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COVID-19 AJAL ILMNENUD MÕJUD PÕLLUMAJANDUSE JA TOIDUTOOTMISE TARNEAHELALE EESTIS (PIIMASEKTORI JUHTUMIUURING)

IMPACTS ON LOCAL AGRIBUSINESS SUPPLY CHAIN AMIDST THE COVID-19 IN ESTONIA (A CASE STUDY OF THE DAIRY SECTOR)

Master's Thesis
Curriculum in Agri-Food Business Management

Supervisor: Ants-Hannes Viira

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Annotatsioon: COVID-19 kiire puhkemisega on tekkinud uus ja enneolematu oht nii ühiskonnale kui ka majandusele. Pandeemia tõttu on ülemaailmsed toiduainete tarneahelad silmitsi seisnud väljakutsetega, nii ka piimandussektoris. Magistritöö raames viidi läbi COVID-19 mõju majandusanalüüs piimatoodete tarneahelale Eestis, keskendudes kehtestatud reageerimismehhanismide efektiivsusele, samuti pandeemia võimalikele pikaajalistele mõjudele. Kasutades kvalitatiivset ja kvantitatiivset raamistikku, kombineeris see uuring intervjuud iga-aastaste aegridade andmetega. Nii nõudluse kui pakkumise poolelt on COVID-19 mõju piimandussektorile ilmnenud järk-järgult ning mitmel viisil, mõjutades kaubandust, rahastamist, töötlemisvõimet, sissetulekut ja turu struktuuri. Vaatamata sellele, et piimatööstusel on aasta jooksul mõnevõrra õnnestunud šokist taastuda, järeldab analüüs, et pandeemia on kiirendanud käimasolevaid struktuurimuutusi piimasektoris. Uuring täiendab kasvavat kirjanduse hulka, mis käsitleb COVID-19 pandeemia keskpikka ja pikaajalist mõju toidusüsteemidele kogu maailmas, laiendades olemasolevaid teadmisi pandeemia mõju kohta piimasektoris. Vaatamata sellele, et tulemused on esialgsed, annavad need väärtuslikku teavet valdkondlikeks aruteludeks.

Märksõnad: tarneahel, piimasektor, COVID-19, Eesti.

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Abstract: A new and unprecedented threat to both society and economies has emerged with the rapid outbreak of COVID-19 pandemic. As a result of the pandemic, global food supply chains have faced challenges and also in the dairy sector. An economic analysis of COVID-19's impact on the dairy supply chain in Estonia was conducted with a focus on the effectiveness of the response mechanisms that have been established, as well as possible long-term effects of the pandemic. Using a qualitative and quantitative framework, this study combined interview with data from state annual time series. From both the demand and supply sides, the prevalence of COVID-19 has been perceived as a series of vignettes affecting the dairy sector. These ripples have influenced the sector in various ways based on the trade profiles, relative financing constraints, processing capacity, per capita income, and market structure. Despite the fact that the dairy industry has somewhat managed to recover from the shock within a year, the analysis concludes that the pandemic has accelerated ongoing structural changes in the dairy sector. The study contributes to the growing body of literature on the medium- and long-term effects of the COVID-19 pandemic on food systems around the world by expanding existing knowledge about the effects of the pandemic on the dairy industry. However, despite the fact that the results are preliminary, they provide valuable information for sector - wide policy debates.

Keywords: Supply Chain, Dairy sector, COVID-19, Estonia.

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List of Abbreviations and Terms

SCM	**Supply Chain Management**
SCI	**Supplier Chain Integration**
GAO	**Gross Agricultural Output**
SC	**Supply Chain**
SCOR	**Supply Chains Operations Reference**

INTRODUCTION

In the past two decades, the dairy industry has been the most prominent industry in the agri-food sector in the Baltics. Joining the EU (European Union) in 2004 gave room for growth in Estonia, Latvia, and Lithuania in its dairy industries and opened the EU market to Baltic dairies, also allowing for their local demand to be fully satiated and also for dairy products to be exported to other parts of the world. An examination of the dairy supply chain in general in the Baltic countries done by (Zvirbule and Rozentale, 2015) concluded that the supply chain has common features which are exclusive to a certain market such that: 3-4 significant milk processing units in each country define trends in the market and the gross margins for milk processors within the Baltic States are between 2 and 4 percent of total throughput. The private market brands of commercial establishment chains (RIMI, Maxima) continue to play an important role within the dairy industry in the Baltic States, while foreign investors are also interested in the consolidation of enterprises which influences the increase of foreign investors entry into foreign supply chain management initiatives.

According to (Viira et al. 2015), in foreign markets, the Estonian dairy sector has remained export-oriented and competitive. The strength of Estonian dairy sector lies in the high milk yields and relatively large farms, low costs of dairy products transportation. Although, there are aspects of dairy farms that require improvement at the same time, the dairy sector is fundamental to the Estonian economy and agriculture with an estimated 24% share in milk from the total gross agricultural output (GAO) as at 2020, and 22% share of dairy products manufactures from the total production of foodstuffs in 2019 and an approximate 15% share of dairy products export CN codes 0401-0406 (0401 – milk and cream, not concentrated; 0402 – milk and cream, concentrated; 0403 – buttermilk, curdled milk and cream, yogurt, kephir and other fermented or acidified milk and cream; 0404 – whey; 0405 – butter and other fats and oils derived from milk; dairy spreads; 0406 – cheese and curd) from the total amount of agricultural products (food and live animals) exports correspondingly in 2020 according to statistics Estonia as seen in Table 1.

T**able 1:** General overview 2015-2020

% Turnover	2015	2016	2017	2018	2019	2020
Share in percentage of milk in GAO	19.75	23.50	28.04	27.25	24.37	24.37
Share in % of dairy manufacture in the food industry	21.25	21.30	23.60	24.12	22,70	-
Share in % of dairy products in export of agricultural products	11.80	12.20	14.84	15.64	14.35	14.50

Source: Statistics Estonia.

The supply chain (SC) is often described as 'a mutually and cooperatively workable system of interconnected and intertwined organizations that regulates and enhances material flows from suppliers to end consumers.' (Flynn et al. 2010). In supply chain analysis, there are two approaches, the managerial analysis perspective which is usually stemming from one company perspective which comprises of the organizational structure, communication and information exchange, information technology systems, forecasting, sales and operations planning, leadership and strategy; and the sectoral perspective which comprises of all actors involved in the supply chain. The participant network depends on the product, the geographical distribution of supply and demand, and customer service requirements, and on its size and scope. It is reasonable to state that no two supply networks are identical and the function of a participant in each network might differ. On the other hand, supply chain management (SCM), as a significant business function, helps companies to fulfil the demand of customers effectively and efficiently. SCM is a broad topic covering networks of tasks that deal with the management of upstream (from supplier to manufacturer) and downstream (from manufacturer to final consumer) partnership in such a way that the flow of products, services, money, and the information is seamless (Christopher 2016).

The supply chain (SC) concept which emerged in the 1990s as a strategic management tool, has become a key driver that enhances overall organizational performance (Maestrini, Luzzini, Maccarrone & Caniato, 2017; Ataseven & Nail, 2017). This strategic aspect of the SC has been investigated by several studies through empirical examination of the associations between different SCM contextual factors such as organisational, industry and operational performance (Wong, Boon-itt & Wong, 2011; Dekker, Groot & Schoute, 2013). For the managers of supply chain activities, it is crucial to monitor both internal and external environments of the firm (Tan, Kanna & Handfield, 1998). Internal environment, often known as a micro level factor, includes elements such as employee, product and service, financial aspect, organizational vision and

goals, internal culture, strategies, competitive advantages and so on (Christopher 2016). The external environment, popularly referred as a macro level factor, consists of competitors, industry rivalry, customer demand, the economic condition of the market (both locally and globally), regulatory frameworks, and so forth (Ibid.).

COVID-19 pandemic that started in the end of 2019 has disrupted the global supply chains. This disease that has not been previously identified in humans. In rare cases, animal coronaviruses can infect humans and, even more rarely, they can be transmitted from person to person through close contact (World Health Organization, 2020). A large number of industries were affected by this worldwide pandemic, some positive such as food delivery companies, online communications technology companies with likes of zoom, skype etc, some negative such as domestic tourism sectors, aviation industries etc. (Haydon 2020), and a few were not affected in any way. Also, farming industries worldwide have been affected by the COVID-19 pandemic (Barichello 2020; Brewin 2020; Kerr 2020; Morton 2020; Pulighe and Lupia 2020; Siche 2020; Stephens et al. 2020; Timilsina et al. 2020; Zhang et al. 2020). In February and March of 2020, for instance, China extensively reported that several dairy farms, particularly small farms, just could not sell milk even at lower prices and other farmers had to dump milk (Hua et al. 2020; Jin 2020). As far as implications on agricultural output and income are concerned, there have been limitations on the transboundary mobility of individuals and lockdowns therefore adding to labour-consuming deficit for farming industries in several nations. For example, recently enacted travel prohibitions inside the EU (European Union) have drastically limited the potential fruit and vegetable workers in a number of European nations, also because the closing of the Schengen Area (OECD, 2020). Dairy farmers saw a decrease in dairy prices as a result of the corona virus epidemic caused by worldwide market pricing, shutdown of workplaces and schools. Dairy plays a crucial role in the restaurant business and the pandemic affected sales and possibly interrupted food services (Stephenson, Shutske, 2020). In regard to the virus, a range of ideas have been made in various countries and organisations, for instance in social distance, decreased travel, crowd avoidance, factory and restaurant shutdowns and other safeguarding procedures to restrict the spread of COVID-19.

Every day, our daily lives are more seriously affected by the epidemic. According to (Golwelkar, Navlakha, 2020), the supply chain has been substantially disrupted. For instance, the gap in product and demand, disturbance in logistics operations and inventory disruption are

some of the probable issues faced by industries or they will experience in the future. In the current global business environment, supply chain management has attracted extensive attention from both academic and industrial circles. Constant dynamic nature of supply chain field, fragility and supply chain risks are increasingly becoming areas of interest in supply chain management. Many studies such as Almena et al. (2019), Chandra and Grabis (2007), Chopra and Sodhi (2014), and Christopher and Lee (2004) suggest that supply chain risk management has a significant effect on a number of stages in the business operation process which includes supply chain networks, finance process as well as operation and business strategies. Market demand uncertainties, cost pressures and externalization are some of the hazards that could occur (Hachicha and Elmsalmi, 2014; Lavastre et al. 2012).
Globalization of food supply, economic growth as well as improvement of living standards, change in eating habits and consumption have led to growth and development of supply chain and studies related to food industry (OECD 2020). Whereas the COVID-19 pandemic has a large global influence on the dairy sector, economic and policy researches are very essential, particularly comparative analysis, to determine the processes by which a pandemic affects the dairy sector implicitly or explicitly. These investigations and examinations can also assist to draw up policy suggestions and industrial plans to reduce the effects of these and future pandemics and to strengthen the industries' ability to tackle unexpected shocks in the future.

Measuring the performance of whole supply chains is an important component in supply chain management, since it enables productivity and efficiency performance to be "monitored and measured" and leads to a better-informed chain design choice. A need to go outside the limits of particular companies that incorporate the full chain is necessary to enhance the performance of the entire supply chain. Therefore, a performance measuring system must be connected to a cohesive system that incorporates several areas of performance since this integrated system increases information flow throughout the chain. The selection of relevant performance indicators for the supply chain is therefore fairly complex because of the various inputs and outputs in the chain. Food supply chain coordination between production and consumption is important to maintain the safety and quality of different foods.

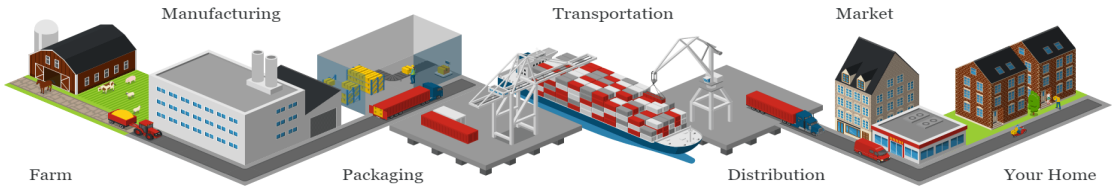

Figure 1. Food Supply Chain. Source: Icograms (2021)

Research to analyse the dairy industry supply chain before and during the pandemic and assess the economic implications on actors with the changing use of the dairy products by industry in Estonia is important because the Dairy industry in Estonia provides over one-fourth of Estonian agriculture's income (Murakas 2021).The present study will examine the existing channels for the dairy product supply chain in Estonia and analyse the impact on quantity and price changes on dairy products, domestic demand, export trade volumes, profit and the return to labour in the processing of dairy. This is because studies on the dairy industry supply chain focussing on the economic implications of the COVID 19 restrictions on the actors have not received much attention in Estonia. Such knowledge on the nature of the dairy industry supply chain will bridge the knowledge gap. In addition, an overall analysis of supply chain operators' indicators with the focus on value added, quantity demanded, profit and basically the outside environments popularly referred to as macro level factor will bridge the knowledge gap on economic implications due to COVID-19 on supply chain players involved in value added activities both locally and globally.

This research aims to assess the economic effects of the COVID-19 pandemic on the dairy supply chain in Estonia. Specifically, the questions would be addressed:

The specific questions addressed by the present study are:

1. What are the impacts on domestic demand and supply of milk and cheese production amidst the COVID-19 pandemic?
2. How did the pandemic impact dairy products prices and quantities?
3. How did the COVID-19 affect export trade volumes in the dairy sector in Estonia?
4. What are the recommendations from the impact of COVID-19 on the Estonian dairy sector?

The thesis is organized into five chapters. Chapter one is the introduction, chapter two reviews the relevant literature and the methodology, chapter three describes the methods of analysis used to address the objectives of the study. chapter four presents and discusses the empirical results. Summary of findings, conclusion and policy implications are presented in chapter five.

2. LITERATURE REVIEW

2.1 Theoretical Literature on Supply Chain

2.1.1 Supply Chain Management (SCM)

Supply chain can be described as all activities between a company and its suppliers with the aim of making goods and services available to buyers and consumers. It is a network between a company and its suppliers for the production and distribution of a specific product to a customer or end-user (Heckmann et al. 2015). The supply chain can also be thought of as encompassing all activities related to the flow and transformation of goods from raw materials to the end-user, as well as related flows of information (Sweeney 2011). Generally, the supply chain constitutes a series of interrelated and connected activities that involve planning, controlling and coordinating materials, parts and finished goods from the raw materials stage to end users (Stevens 1989).

Activities of the supply chain are made up of sourcing and procurement, system management, inventory management, warehousing, transportation, and customer service (Lambert, Cooper & Pagh, 1998). SCI (supply chain integration) involves supplier integration, customer integration and internal integration (Flynn et al. 2010). According to Flynn et al. (2010: 58) ‘‘*it is the degree to which an organization strategically collaborates with its supply chain partners and collaboratively manages intra-organizational and inter-organizational processes, in order to achieve effective and efficient flows of products and services, information, money, and decisions, to provide maximum value to the customer*’’.
Integration of these activities affect each other to enhance performance. Based on these elements, Cooper, Lambert and Pagh (1997) and Lambert et al. (1998) describe SCM as the integration of key business processes which involve end users through suppliers and offer value added products, services and information to customers and other stakeholders. More precisely SCM constitutes a key business process integration among a network of inter-dependent suppliers, manufacturers, distribution centres, and retailers to enhance the flow of goods, services and information from suppliers to customers at relatively reduced costs.

However, different notions of the SC which demands different forms of accounting information at different levels of sophistication and complexities exist (Burritt, Schaltegger, 2014) and this study focuses on that of the health SC which in relation to mainstream discrete parts and consumer goods, is complex, sophisticated and more expensive to operate (Shah 2004). Although the SC has become a key driver that enhances overall organizational and industry performance in contemporary businesses (Maestrini et al. 2017), there is evidence of underdevelopment of research that relate the specific associations between its contextual factor, organizational or industrial performance (Ataseven & Nair, 2017). The key SCM dimensions include supplier integration, customer integration, internal integration, transfer of knowledge (or information sharing), risk associated with the external environment (or trust), and postponement (Chen et al. 2013).

In addition, there is diversity of lack of standardization of the nomenclature that characterize the SCM practices. This has resulted in a confused understanding of the fundamental concepts of the area (Behesti et al. 2014). Indeed, intended results that are unprecedented to other management tools are provided by the supply chain. However, managing supply chains whether as a strategic, tactical, or operational management tool must be deeply rooted in four principles; supplier relations, sharing of information (or knowledge exchange), risks and benefits (Ibid.).

Supply chain activities date back to prehistoric times. It is known that man wandered from coast to coast in search of food, seeds, raw materials, trade, etc. Ancient trade routes such as the Silk Road through Central Asia and the Spice Route through the Indian Ocean, as well as major trade routes across the Sahara. The desert between West / Central Africa and the trading port centres along the Mediterranean and the route from Timbuktu through the Sahara to Sijilmas were mostly linear chains through which the finished product was transported to its final destination (Heckmann et al. 2015). In addition, given the high cost, long-distance trade was limited to high-value items such as spices, weapons, and jewellery. It was proof that supply chain activities are part of humanity.

The performance of the supply chain represents the cross-functioning of systems and collective responsibility across functions from a strategic perspective. Collaborations across procurement, warehousing and distribution functions take place within internal integration to meet customer requirements at a low total cost (Qi et al. 2017). Another indicator of an efficient supply chain

is the internal integration efforts which facilitate the sharing of real-time information and knowledge across key functions through the break-down of functional barriers (Wong et al. 2011). These functional barriers can significantly affect inventory management and warehousing, quality of dairy processes and farm costs, operating cost of inputs facilities, commodity throughput, costs and cost drivers, etc. that have significant effect on SC operational performance. Furthermore, the SC constitutes the most critical element in overall industrial cost control and has become one of the most important and critical areas for managers and industry experts (Barlow 2010). This is because improvement upon overall efficiency and cost reduction strategies have been a challenging issue in food supply chain (Pizzini 2006; Abernethy, Chua, Grafton & Mahama, 2007).

The resilience to various crisis situations such as Covid 19, and especially the establishment of trustworthy links between producers and final consumers, is just a few of the arguments that will contribute to food security through the development of supply chain improvements and food chain management systems.

2.1.2 Supply Chain from A Macro-Perspective

As a part of a larger macro-group (external characters of the supply chain), the supply chain has been more and more taken into consideration as a micro-group (internal characters of the supply chain), which means that the emphasis is habitually based on character businesses or the interplay of particular corporations. Gunasekaran et al. (2004) supported a hierarchical inventory network execution system, through the receipt of an execution estimate SCOR (supply chains operations reference) model which illustrated that diverse implementation measures should be used to assess the force of the SCOR method in view of the different times of the SCOR method (making-request transport arrangements). They refer to the involved organizations, who are also concerned with the appraisal of client loyalty (supply connection and conveyance interface).

According to Burfisher (2021), macro-economic impact research of pandemics generally is based on (CGE-models), which are equation systems that constitute a whole economy, taking account of all the interactions between the players in the economy including production, consumption, employment, taxation, savings, trade and all their interrelationships into account.

The main interest for research purposes is to highlight the transmission channels associated with pandemics and McKibbin and Fernando (2020) have adopted the GCE approach for preliminary quantification of the impact of COVID-19, without detailing their projected scenarios. Pandemics are modelled specifically on simultaneous shocks to supply and demand which have heterogeneously affected economies across sectors. The transmission route from the supply side concerns the reduced availability of jobs because of the higher mortality and morbidity rates and restrictions on the mobility of workers. On the demand side, these studies show that pandemics have a major influence on social-consumption activities, such as in restaurants and bars, and on personal service that can easily be postponed. In the same way, travel and retail sales services can experience a significant decline in demand.

Keogh-Brown et al. (2010) show that although the SARS epidemic did not have a significant impact on local production, the restrictions on its cross countries impact have affected the exports quite severely. Highly income countries show that COVID-19's short-term effect was massive, particularly as a result of labour shortages, logistical and transport restrictions and changes in consumer demand, in the months immediately after the outbreak (Weersink et al. 2021). These countries were, however, able to recover completely from the initial crisis in a few months and show great disaster resilience shocks.

Most vulnerable in a pandemic is a disruption in demand, as this drives any supply chain and, if it's affected, could lead to systemic failure. Another factor that may have a significant impact on supply chain performance is supplier reduction. Stoppage of production is another important factor in a pandemic. In addition, this driver will have a major impact on the businesses of firms (Ivanov 2020). A small number of other drivers may not be affected, but it has a significant impact on Supply chain performance.

2.1.3 Empirical Studies on Agri-Food Supply Chains

In the 'farm to fork' distribution chain, there is a complex web of links. An important part of managing Agri Food Supply chains is structuring the product flow from primary manufacturer to final consumer (Bhatia and Janardhana, 2020; Mor et al. 2018; Khan and Yu, 2019). Any agri-food supply chain is designed to provide an efficient and comprehensive flow of products, services and information, transfer capital to maximize customer value and deliver. The

efficiency of an agri-food supply chain is deemed as if activities, operations and processes reduce overproduction, remove inventories that are no longer required, minimize stock activity, streamline chain movement, reduce downtime or detours and reduce waiting time until waste and non-compatible items have been disposed of. Irrespective of the organisational shape of any agri-food supply chain, the enterprises might pick a strategic development approach: strategic procurement planning, growth in labour productivity, enhanced financial performance, improved distribution efficiency.

To meet the unexpected demand and supply of agricultural products, Estonia's Agri-food supply chains require immediate reorganization and more brainstorming to maximize efficiency. The 2014–2020 Rural Development Programme for Estonia aims to improve the balance of the food supply chain in Estonia. Producer organizations are seen as a good way to help farmers become more organized, market their products more effectively, and move up the value chain as a result (Kiely 2014). It is clear that food processing has undergone significant changes as a result of this pandemic. There are a number of threats that must be addressed by organizations that participate in and collaborate with food supply chain practices. More attention is needed throughout the supply chain flow due to the growing concern about food nutrients and the growing interest in their safe packaging, freshness, and demand for some specific food products, including immunity-boosting products. The private sector and markets can both benefit from coherent measures. Where markets can play a valuable role and private capital funding can be increased, coherent measures are also required. In part because the FSCs act as intermediaries between primary producers and end consumers, a supply chain analysis combined with green management practices can help FSCs overcome this substantial economic loss. (Yu et al. 2021; Khan et al. 2020)

According to Ahumada and Villalobos (2009), in terms of the environment, demand and business climate, the supply chains of Agri Food are the most fragile. All the main repercussions were separated into four groups: business effects, logistical effects, financial consequences and social and environmental implications for the purpose of evaluation.

2.2 Empirical Literature on The Effect Of COVID-19 On Supply Chains

2.2.1 How COVID 19 Pandemic Affect Global Supply Chain

The manufacturing industries and dairy processing companies have been affected massively by the outbreak of the COVID-19 pandemic. Industries around the world have had to assess the impact of the corona virus on their businesses and plan on steps to survive following the continual spread of the virus globally. Demand for food has witnessed an increase as consumers rush to stock up to avoid being caught up in a possible quarantine, businesses have been faced with a task to meet up the demand level and secure the supply chain which hasn't been an easy task. For example. exports to and from China has been badly hit by the imposed travel restrictions, and has adversely affected the positive development of dairy products around the world. Analysts have predicted a cycle of recession in world dairy markets showing that the US demand has reduced from 0.8% to 0.5% (Byington 2020).

The impact of COVID 19 on the global supply chain cannot be underestimated. Many countries, provincial and municipal governments have passed laws, emergency laws to support the supply chain sector, especially health and essential goods (Siche 2020). According to Lisa Thompson, Minister of Government and Consumer Services. "That is why we are enacting the Supply Chain Management Act to ensure that we can deploy critical materials, equipment and services where they are most needed" (Guan et al. 2020). These regulations will allow the Ministry of Government and Consumer Services and the Ministry of Health to centrally manage supply chains in the public sector. This will allow the collection of key data on stocks, orders and supply restrictions, as well as the development of a virtual inventory tool so that the demand for critical supplies is visible and traceable; By taking these steps, the government can prioritize procurement of what is most needed, implement, and prioritize procurement to support the provision of essential services to Ontarians (Government and Consumer Services 2020). "Ontario has implemented critical and necessary measures to ensure that we can protect the health and well-being of the people of Ontario," said Christine Elliott, Deputy Prime Minister and Minister of Health. With innovators and companies across the province that can supply food in emergencies and innovative solutions to support ongoing efforts to contain COVID-19." (News.ontario.ca 2020) Several steps have been taken at all levels of government to ensure

that essential goods reach those on the front lines and those in need. These measures become necessary as COVID 19 threatens supply chain activities. According to Machinedesign.com, nearly 75% of companies reported supply chain disruptions in some capacity due to coronavirus as a result of transportation restrictions and more than 80% believe their organizations will experience some impact due to COVID-19 disruptions (Guan et al. 2020). Delivery times have also doubled, and the shortage is compounded by the limited number of air and ocean freight options to get product to the United States, even if they can fill orders.

According to Baldwin & Weder di Mauro, (2020), A number of catalysts of economic growth have been adversely affected by COVID-19 and have adverse growth effects as supply chains are disrupted. In addition to direct supply deficiencies (i.e., lower exports), it will be even harder for the countries concerned to obtain supplies to produce goods, The logistics' growth effects are susceptible to the prevailing national growth rates. In particular, the low-end countries in terms of growth tend to benefit considerably from logistical performance improvements. On the other hand, in the present COVID-19 pandemic such nations can be contested particularly when supply chains are affected or stifled by various factors. The bottlenecks in the supply chain could have secondary effects on the globalized economy across nations. These findings also argue against general policies to promote growth in countries with different rates of growth (Rajeev et al. 2021).

Espitia, Rocha and Ruta, (2020), in their paper, wrote that a price decline of foodstuffs was also seen as a result of a constraint imposed by many governments on exports to ensure the short-term availability of food products in the domestic markets, compared to the rising costs of production and delivery due to the restriction of movement or the labour scarcity. The farmers have suffered a significant loss. The traders lost their reputation and confidence in foreign marketplaces due to export restrictions. The worldwide commercial opportunities were also harmed in the future. The main steps to control the spread of COVID-19 according to (Amjath-Babu et al. 2020) have been identified as restricting transport and quarantining, with the potential for delays and interruptions to the Agri Food supply chains. Borders and further efforts to monitor the CORONA cases and food safety checks led to congestion and further delays. Differences in the economic sustainability have contributed to a reduction in inspection time and customs processing at borders. With the suspension of aviation services, the export of items such as fish and fruit and vegetables were caused by a huge challenge. In

contrast, due of bulk shipping and the limited labour requirements for processing, the effect of the interruption was not considerable for basic food supply (cereal).

Generally, there were impacts of COVID-19 on Agri Food supply chains reviewed in some literatures and some of the impacts were; lack of trust in international trade, Poor accessibility and availability of key intermediates, Transport restriction, Import Disruption, Supply and Distribution uncertainties, Price volatility, Loss or wastage of high-value (perishable) products, Migration of workers, Shift in consumer demands/behaviour. The whole Agri Food Supply chains depends on the farmers' production and supply of the products. Any delay in the accessibility of important intermediates might lead to lower output and so damage the overall food business. The accessibility of information during the crises are also emphasized in literature because it makes the food supply chains transparent (Forslund and Jonsson, 2009).
In terms of the supply chain strategies to reduce the impact of COVID-19 on Agri Food Supply Chains, many literary solutions to address the difficulties in the Agri Food Supply Chain have been suggested. Pravin kumar, Rajesh kumar singh, (2021) in their paper outlined that in recent times, most pandemics have affected some parts of the world, but the effects of the recent coronavirus are radically different. It triggered the total shutdown and the effect on the world. Studies in contexts are therefore relative in many locations and nations. There is a lack of enough documentation leading to a thorough review of COVID-19 influence on Agri Food Supply Chains and there have also been limited investigations of measures to reduce the impact of COVID-19 on Agri Food Supply Chain activities.

2.2.2 How Covid 19 Pandemic Affect Dairy Supply Chain

The coronavirus outbreak that started in Wuhan, China since the wildfire has spread around the world, cutting off many supply chain operations and doubling delivery times (Siche, 2020) has brought a new narrative and a paradigm shift to the global supply chain. This period was characterized by high demand for scarce medicines, as countries around the world faced a shortage of dairy products needed to combat the spread of the virus. The pandemic was considered to be a wave of events that had an effect simultaneously on the demand and supply side of the dairy sector as shown in a study by Acosta et al. 2021. The sector has suffered differently from those waves, depending on the trade profile of regions and countries, relative scarcity of resources, per capita income and market structure. Some insights from various

literatures suggest that the pandemic's effect goes further than the immediate short-term effects. some of the effects are shown in the table 2 below.

Table 2: Effects of COVID-19 on the global dairy sector by segments (production)

SEGMENTS	EFFECTS	AUTHOR
Production in US	After the COVID-19 outbreak, the foodservice industry shut down in large numbers, resulting in a major oversupply and a drop in milk prices in the US, according to Donald Moore, Executive Director of the Global Dairy Platform	Acosta et al., 2021
UK	"The pandemic in the UK resulted in an increase in price volatility," said Judith Bryans, CEO of Dairy UK and President of the International Dairy Federation (IDF). Farmer prices dropped by approximately 14%. A further decline in prices was observed in the following months, despite the fact that the immediate effect of the shock on prices was not as bad as originally anticipated	Acosta et al., 2021
South America	As a result of the pandemic, dairy products such as milk, yoghurt and cheese were in high demand in Mexico. Grupo Lala, a major producer's cooperative in Mexico, increased sales of dairy products by 14 percent after the start of the crisis As reported by Eduardo Schwerter, President of the National Federation of Milk Producers in Chile (Fedeleche), between March and May 2020 the price producers did receive per litre of milk at the local farms in Chile increased by about 10 percent	Acosta et al., 2021
Africa	As Tariku Teka, Director of the Dairy Directorate of the Ethiopian Ministry of Agriculture, explains, transportation restrictions have made it difficult for farmers to reach milk collection centres and for processors to collect milk from producers Kenya's production was also interrupted due to higher transportation costs and farmers' inability to receive quality inputs and training, according to Nakuru Country Dairy Cooperative Union secretary Laureen Mwikali Nkuguina. Families are forced to switch to non-livestock products because of the increase in household expenses	Acosta et al., 2021
Asia	There were only minor effects in India and Thailand. Sangram R. Chaudhary, Executive Director of the National Dairy Development Board and Managing Director of its farm Mother Dairy, goes on to say that in India, the world's largest producer of milk, the production of many small producers helped to mitigate the effects of the shock. Producers shifted part of their milk supply to those processing traditional products with higher retail sales to accommodate increased home consumption in order to cope with the decrease in demand from commercial channels CFS Chair Thanawat Tiensin says that in Thailand, the impact of the demand shock, and consequently production, was barely noticeable	Acosta et al., 2021
General	Production and input prices have become more volatile as a result of the pandemic. Producers' returns have decreased and production systems' economic viability has been compromised. Pandemic has forced many producers, especially smallholders, to leave the sector. Though not an entirely new phenomenon, the pandemic has intensified an existing trend that had been in place for many years prior to its outbreak	Acosta et al., 2021

Table 3: Effects of COVID-19 on the global dairy sector by segments (processing)

Processing in Asia	Ms. Zaugg said that reorienting milk processing and adjusting packaging were two major challenges for Nestlé China. One plant in North East China processes fresh milk products, and the other produces powdered milk. Milk had to be transported from one plant to another, from the liquid to the powder plant. It had to change packaging formats from one-litre to smaller packs as demand shifted from the foodservice sector to retail	Acosta et al. 2021
Africa	"The restrictions on labour movements, transportation, and trade hampered the cooperative's performance," says Phillip Pyeko of New Kenya Cooperative Creameries Ltd. (NKCC). The company's processing capacity was affected by the labour shortage, and some machines sat idle. As a result of the adoption of social distancing measures, the number of workers per shift was cut in half, resulting in less labour for the cooperative to operate with. Elaboration and distribution were affected by the difficulty of importing fermentation starters and packaging	Acosta et al. 2021
South America	Compared to other food processing plants, dairy plants are less likely to have outbreaks due to their working conditions and facilities, including biosecurity measures, food safety standards, and plant cleanliness, says Luiz Guedes, Danone's director of milk quality and food safety. Dairy plants are highly automated, so implementing social distancing was relatively easy	Acosta et al. 2021
Americas	Single-desk milk sale resulted in Canadian dairy farmers being priced on a manufacturing cost basis by processors from various categories of milk products adjusting their milk demand Compared to in the U.S. where the dairy farmers typically sold to a market cooperative for which processor demand often decreased significantly, the Canadian system with central selling and transport coordination has reduced dumping	Nicholson et al. (2020), (Weersink et al. 2020).
General	The vast majority of processors could continue to operate throughout the pandemic. Many dairy processors said they had to invest in improving the transportation capacity of fresh milk in order to meet consumer demand for more milk. Plants for the processing of milk have been standardized to a greater degree, ensuring that products meet quality and safety requirements. In the case of traditional processors, financial constraints made it more difficult to adopt stringent processing standards	Acosta et al. 2021

Table 4: Effects of COVID-19 on the global dairy sector by segments (Domestic demand)

Domestic demand in South America	According to Oscar Cubillos, Head of Planning and Economic Studies at the Colombian Cattlemen Federation, fluid milk sales in Colombia increased by 25 percent in March 2020 compared to the previous month As a result of the increase in retail sales in Chile, the decline in foodservice channels has been partially offset, according to Octavio Oltra of the Chilean Dairy Consortium Expert Paulo do Carmo Martins of Embrapa Brazil says that while the demand for fluid milk, UHT milk, and milk powder has increased, sales of cheese and yogurt have dropped in Brazil. Fabio Scarcelli, president of the Associaço Brasileira das Indstrias de Queijo (ABIQ), indicated that cheese sales fell by at least 60 percent at the start of the quarantine as a result of the shutdown of the foodservice sector, which typically absorbs 30 percent of cheese production	Acosta et al. 2021
Europe	Europe has seen an increase in demand for fresh products such as mozzarella cheese, cream and butter, say Kees de Roest, head of the CRPA's Department of Agricultural Economics and Luis Calabozo, secretary of InLac in Spain. To compensate for the reduction in food services, they suggested that consumers increase their home cooking activities to compensate	Acosta et al. 2021
US	Despite the fact that the decline in the foodservice sector was partially offset by an increase in the household demand, in many countries, the increases were not strong enough to offset the declines. 90 percent of the cheese market in the US has disappeared, according to the National Milk Producers Federation (US NMPF)	Acosta et al. 2021
General	With the easing of lockdowns, the demand for food services has increased. Studies have also revealed that the pandemic has made consumers more aware of healthy eating and food safety issues. In addition, the restrictions on movement prompted consumers to try online shopping for the first time. Online distributions have become a much more relevant marketing channel as a result of this. As a result of these trends, milk and dairy products are likely to become more popular in the medium term, as consumers become more aware of the benefits of eating healthy foods	Acosta et al. 2021

Table 5: Effects of COVID-19 on the global dairy sector by segments (International trade and price movement)

International trade and dairy price movements	From January to May 2020, international dairy prices, measured by the Food and Agriculture Organization of the United Nations (FAO) Dairy Price Index, declined by 9.4 points (9.1 percent). The index is based on four dairy products traded on international markets — butter, cheese, skim milk powder (SMP), and whole milk powder (WMP). In this period, SMP prices fell by 25.1 points (21.9 percent), followed by butter at 17.4 points (15.8 percent), WMP at 16.3 points (14.9 percent), and cheese at 0.8 points (0.8 percent) Due to increased imports from China, Algeria, Saudi Arabia and Brazil, international trade in dairy products increased by 0.3% in 2020, compared to a five-year average of 1.6 percent between 2015 and 2019. Dairy exports to China increased 7.4 percent in 2020 as a result of the early end of COVID-19 lockdowns, rising per capita consumption, and expanding consumer base In the first quarter of 2020, the EU, the world's second-largest exporter of SMPs, experienced a 24 percent decline in exports as shipments to main trading partners contracted by rates ranging from 12 percent in China to 68 percent in Indonesia to 13 percent in Egypt (Trade Data Monitor, 2020). In the meantime, the EU's internal demand was declining and milk production was steadily increasing, resulting in a rise in export availability, while global demand was declining	Acosta et al. 2021

In summary from the reviewed literatures in the tables above, the pandemic had a variety of effects on producers in exporting, importing, and self-sufficient nations. This led to an oversupply of milk in most exporting countries, which in turn led to a drop in producer prices, which was significant in some cases. When it came to importing countries, the effect was largely determined by the market channel in which the producers were active. Some small-scale farmers were forced out of the market as a result of the pandemic's impact on input costs, as well as increased environmental and safety regulations. It was the dairy processing industry's responsibility to make sure that the plants were kept in good working order and that milk was collected every day. As a result of isolation measures and irregular access to processing inputs, people in developing countries have suffered. In the year since the outbreak, the majority of processing plants have adapted to the new distance measures and are back to full production capacity financial constraints have made it difficult for traditional processors to adopt more stringent processing standards. Depending on average income of households and the price elasticity of demand for dairy products, domestic demand differs from country to country. As a result, dairy product sales in low-, middle-, and high-income countries declined. As dairy products were added to the list of essential perishable foods in several countries, the consumption of long-life products increased as a result of their longer shelf life. This means that rather than increasing in terms of value, the increase has been in terms of volume of specific products Consumption of higher-value dairy products declined, while consumption of lower-value dairy goods grew.

Global demand for dairy products fell more than global export availability, causing international dairy prices to increase their volatility. As a result of the shock to the dairy industry, the governments instituted a series of measures to mitigate the effects. Food, including dairy sub-areas, may have been exempted from development restrictions in terms of transport, workers, and merchandise. Various other reaction systems focused on promoting utilization or reducing value instability by enacting plans like guide for private stockpiling, market support liability programs, food buy and circulation, and the promotion of utilization crusades by some private and public area elements.

2.2.3 Demand and Supply Crisis of Dairy Products

According to Analysts, a fall in export demand for dairy products is possible because shipments have to go through rigorous protocols before they get to certain locations around the world. This will lead to delay and further cause a can cause massive reduction in price which could be a serious problem for the industry. However, in short term, demand for dairy products could see a positive rise if suppliers can keep their shelves full. But as the corona virus continues to spread, manufacturers may not be able to keep up with demand and lives of employees of dairy companies could be endangered if there is detection of the virus around farm locations (Byington 2020).

Before the corona virus outbreak, the dairy industry has been affected with several rise and fall which has made consumers turn to cheaper private label products, alternative beverages and plant-based options. The Milk Processors Association of Canada (2020) shows the positive response of dairy processors to reduce the spread of the virus and ensure continuous operations in the food supply chain by using the social distance measure. A crisis management team was developed whose duties was to protect the health of employees and ensure non-stop services to the company. This method drafted a working schedule that allows only necessary production and warehouse personnel get involved in the work while all other personnel work remotely. This however created an imbalance between supply and demand and a slight decline in the company's production capacity. On the other hand, the food processing facility has also adopted very strict hygiene measures to support food safety requirements. This caused many waste pickers to step up health measures for key employees who come to work every day to render services to the country.

However, Bangladesh have not been able to meet up with demand and secure of the supply chain despite the increase in demand for dairy products as consumers try to stock up for possible quarantine and restriction of visits to grocery stores (Udine 2020). With the introduction of additional travel restrictions for fear of the spread of the virus, exports to China have reduced massively thereby affecting the positive dynamics of dairy development around the world. Dairy products which are imported into China from the United States have been faced with this obstacle of restrictions as a result of the outbreak of the virus, hence this will lead to increase of milk stocks in the main exporting countries and will affect the fall in world milk price on the long run (Udine 2020).

2.2.4 Effect on Product Loss / Dump

In a bid to prevent further spread of the COVID-19, many schools, cafes, restaurants and businesses that receive milk from producers all over the world were temporarily closed. This caused many dairy farmers to take a break in the market chain, which affected some countries particularly West Midlands where some farmers dumped thousands of litres of fresh milk due to disruption in the supply chain. However, this raised huge concerns globally as some dairy farms could possibly wind up leading to milk shortages when demand resumes after the pandemic (Church 2020). The economic crisis caused by the pandemic also hit Vermont farms and forced dairy farmers to ditch milk because demand has dropped (Digger 2020). Vermont cheese producers were also affected by the economic harsh reality of COVID-19 because restaurants and farmer's markets were closed.

As in other countries, England's dairy cooperatives disposed surplus dairy products due to the outbreak of the COVID-19 pandemic. After the COVID-19 pandemic in the dairy industry, two main markets, restaurants and schools closed up overnight, leading to a surplus of milk in the country and the spillage of millions of pounds of milk that could not be sold. Huffstater (2020) reported that a dairy farm in the North American continent has come under severe attack due to the recent COVID-19 pandemic. Despite high demand for staples such as dairy amid the coronavirus pandemic, there have been many disruptions in the milk supply chain preventing farmers from bringing their products to market. US dairy farmer Lidl said it was shedding 4,700 gallons of milk from its 480 cows a day. This clearly shows that when the coronavirus pandemic broke out in the United States, many farmers had to dump huge amounts of milk,

however same situations occurred in Canada and the United Kingdom. With the amount of milk lost, dairy farmers are facing this serious crisis because of the closure of school, markets and restaurants as a result of the pandemic.

2.2.5 Changing Participants in The Milk Trade and Lack of Transportation

Milk is a dairy product that consists of a large amount of water (87%). This water content makes the milk perishable and for milk to remain in its natural state, milk producers must transform it into other dairy products and delivered to processing plants shortly after harvest. However, during the outbreak of the corona virus, the dairy business was affected more, because the products are very perishable: thus, milk cannot be frozen or put in a silo like grains (Huffstutter 2020).

Dairy farms in the United States sold fresh milk to restaurants and schools in bulk. However, with the outbreak of the pandemic, the United States closed a large number of restaurants and schools that received fresh milk in bulk from dairy farms which led to interruption of milk supply chain for some time. For these reasons, the US agriculture, food and beverage industry has been forced to change its raw milk marketing strategies to save dairy farms from a crisis (Huffstutter 2020). The American dairy farmers were forced to suddenly switch from these wholesale catering markets to retail grocery stores, sparking nightmares in the logistics and packaging of milk, butter and cheese processing plants. This made dairy products in grocery stores became high in demand as consumers stayed home during the pandemic, although panic buying could reduce with time. Travel restrictions have been put in place to contain the spread of the virus (Huffstutter 2020). For this reason, dairy trucking companies are struggling to find enough drivers and sales to major dairy export markets ceased because the catering industry was largely closed globally.

2.2.6 Effect on Farmers Markets and Prices

Dairy producers face a milk price collapse amid the coronavirus pandemic as restaurants, jobs and schools close around the world. Due to the outbreak of the virus, different countries and organizations adopted several recommendations to curb the pandemic, such as social distancing,

travel restriction, avoiding crowds and large meetings, closing schools and restaurants, and applying other protective measures to reduce the spread of the virus. However, this made consumers to battle with food decision (Stephenson 2020).

Dairy products are used a lot for eating out and there may be some interruptions in catering which affects the markets and the prices of dairy products. There have also been bottlenecks at ports in other countries, as ships wait to load with dairy and other American agricultural products. Efforts aimed at assessing the impact of the virus on the economy as a whole, has shown that the virus has a bigger impact on dairy prices. Many countries in the European Union were already just above recession before the outbreak, and the pandemic is likely to push them to the brink. Before the pandemic, China also experienced a slowdown in economic growth (Stephenson 2020).

The US economy was strong, but before pandemic fears arose, and there were leading indicators suggesting that US had passed the peak of the business cycle and that recession was in-view. Jennifer Huson (2020) of US Dairy Producers said that demand for milk has decreased by 12-15 percent in the US, and these changes in demand are causing great uncertainty. Maxwell, owner of the Cinnamon Ridge dairy farm, explained that milk prices have fallen due to the COVID-19 pandemic. He said that a gallon of milk sells for $ 1.25. Before the outbreak of the pandemic in the United States, milk producers faced a drop in prices of around 40% percent in the last two weeks. This resulted from overproduction in the United States dairy market, uptick of corporate agriculture and increase in consumption of milk substitutes such as soy, almond and oat milk by consumers.

As logistics are disrupted and efforts to slow the spread of the virus continue, a number of related industries are affected. For example, in the supply chain disruption on the farm, the American Veterinary Medical Association (AVMA) pointed out that animal pharmaceuticals may be in short supply as major drug manufacturers may not meet up with supply of drugs and which will result in slowdown of the supply chain. If the virus had spread more widely in an agricultural state, there would be problems with the delivery and export of agricultural products as workers especially milk truck drivers may stay home due to illness or they are taking care of family members who are sick.

2.3 Structure of Dairy Herds

According to the structure-behaviour-efficiency paradigm, the structure of companies is the determining factor of supply, therefore, the determining factor of the productivity (competitiveness) of the industry. In Northern Europe, there is a general trend towards large and medium-sized dairy farms. According to Luik (2009), the growth in herds size in Estonia is more than eight times and in the same farm, reaches 60 cows. The current agricultural policy in Estonia - mainly developing large farms - can explain this. Luik-Lindsaar et al. (2018).

In Estonia, there have also been significant changes in the breed structure over time. As a result, Kimura and Sauer (2015) inferred that "there was a growing importance of large dairy farms, where cows are kept indoors all year round, and changes in the structure of dairy breeds, the seasonality of milk production in Estonia has decreased significantly". Another key indicator for the development of modern milk yield technology solutions and manufacturing equipment is the number of cows in herds ranging over fifty. According to a research done by A. Leola et al. (2021), the averaging size of cow herds has increased three to four times between 2000 and 2019, with the exception of Estonia with an eight-fold increase. Small cow farms with up to 5 animals also exist in every country. In Estonia, about 2% of the total number of cows in these farms is present, but 10-18% of the total number of cows in the other Baltic countries. The modern technologies and machinery of dairy production can mainly be implemented in herds with 50 or more cattle. These herds are approximately 50% of the total number of cows in Latvia and Lithuania, 30% of them are in Poland but 90% in Estonia.

The increase in the size of cattle herds makes it possible for dairy cow farms to be modernized, as well as technology innovation and automation processes to be implemented. 85% of the total number of cows in Estonia, where the highest cow-herd level was reached, were handled loose, and the distinctive workforce in Estonia for people who worked in the dairy sector in 2019 was only slightly higher than 100 men hours per cow/year which was 300–350 hours per cow per year in the other Baltic States.

2.4 Raw Materials

Milk production and processing are two segments of the same value chain. Consequently, their competitiveness is largely interdependent. However, Jansik et al. (2014) has described the phenomenon of raw milk trade as “an indicator of the competitiveness of milk and / or dairy products production”. In Finland, trade in raw milk is negligible, while Denmark and the Netherlands export 3.6% and 2.5% of harvested raw milk, respectively. Germany is an importer of raw milk, although raw milk imports only 1.5% of processed milk. Based on data from Estonian Statistics (2015) trade in raw milk has increased in most of the countries in the Baltic region indicating the relative importance of the product to the region. For instance, coupled with the fact that Lithuania is a net importer of raw milk, the net export of raw milk in Estonia in 2014 amounted to 25.2% of the total collected milk while for Latvia net export of raw milk was 28% of the total collected milk within the same scope of time. Estonian Statistics (2015) also highlighted the imports of raw milk accounted for 18.7% of the imports of milk collection in Lithuania while only 15.8% was processed milk. The accelerating exports of raw milk from Estonia to Lithuania after the crisis in the milk market in 2009 have reached a significant volume over the past 10 years, However, it appears that net imports of raw milk to Lithuania decreased by 2014, while the volume of processed milk increased in Latvia and Estonia.

A review of the dairy sector in n pre, during COVID-19 and post pandemic periods done by Lalita Garg and Kamal Kumar (2021) showed that; the significant inputs in dairy farming are feed and fodder which account for nearly 60 per cent of the overall costs of production. With the size of land decreasing, milk farmers have become more dependent on the market to meet their feed and fodder requirements from various parts of the country (Bhandari and Ravishankar, 2020). Because the livestock feed industry temporarily shut down its production units due to the uncertain supply of raw materials, a shortage of work and transit problems, farmers had problems getting cattle feed. To tackle the issue of livestock feed shortage, the National Dairy Development Board of India intervened by replacing shortages of raw materials with local components (Bhandari and Ravishankar, 2020). Input and credit movement is another main receiving end constituents. Looking at the cost aspect, the prices of all inputs increased more or less.

2.5 Price Signals

According to MacDoanld et al. (2004), the exact pricing and market information that informs market trends and decisions is supported. Market prices indicate the extent of product shortage for consumers, as well as stimulate the production of attributes preferred by consumers. Market prices for sellers provide signals of buyer preferences and stimulate input and service flows. Prices are a mechanism for transmitting market signals across the supply chain. Prices can be a useful means of co-ordinating production in any market. Similar transaction prices should merge to a widely accepted 'market price' because consumers do not pay obscenely high price and sellers do not accept very low prices. Therefore, market prices directly signal consumers preferences to producers in the traditional spot market system and guide production choices towards meeting the needs of consumers.

Multiple component prices are popular in Europe, the US and Oceania for raw milk pricing for manufacturing. The value of milk in processing depends on its various component content. Moreover, with consumer preferences (based on their dairy choice), relative values of different components are changing over time (Atsbeha et al. 2015). Price volatility in the dairy sector is, according to Patton et al. (2018) a key issue. The short-term inelastic supply results in volatile prices in relation to changes in demand. Due to combinations of the milk quota system and other support measures, milk prices were used less likely to fluctuate compared to world prices within EU. In recent years, volatility has become an even greater problem with more integration of the internal market with the world market.

In his investigations, Liu (2020) concluded that the price of dairy products may have been the same, or decreased, in several reasons. "Often prices may be static, i.e., foodstuffs may prefer to react to the situation more slowly." This can also be an effort on the part of retailers to maintain good customer relations, as consumers will not benefit from higher prices. Retailers might also be concerned that they are seen as infringing on pricing bottleneck legislation. The impacts can also be implemented for a longer period and, therefore, at the time of the first shock, not immediately which could also rely on the movement constraints period, the way consumers react, and the intensity of the disturbance of the supply chain. Also, there is the possibility that economic circumstances were such at the time that an extremely elastic section of the demand curve was reached.

3. METHODOLOGY

3.1 Research Design and Approach

Descriptive approach was used to analyse different indicators, based on the indicators specified. The researcher used annual state-level time series data for the period 2015 till 2020, giving 5 years of pre-covid data and one-year covid data. The sample period begins in 2015 and ends in 2019 because at about this time COVID-19 wasn't as protuberant across many countries, especially in Estonia. invalidating it as a potential factor for change or disruption in the Estonian dairy supply chain. Moreover, after 2019 seems like a reasonable limit on the span of plausible prediction of the effect of this pandemic.

In the study, the qualitative and quantitative framework combined interview and state annual time series data. The combination of these approaches provides a more comprehensive understanding of the problems to be analysed, according to Lambert and Loiselle (2008). The researcher organized a separate discussion with a stakeholder in the dairy sector following Liamputtong (2015). The facilitators' role was to provoke discussion and dialogue with the participant. Based upon a review of diverse information sources, such as sectoral analysis, value chain studies, government official reports and newspapers, The researcher formulated proposals and shared the research proposals with the target respondent to stimulate this discussion. The proposals were used to develop the guide for interviews, describing the shock effects along the value chain. The interview was held on an online platform (zoom) and recorded after informed consent was received by participant. I have used a five-step longitudinal quantitative and qualitative analytical framework as seen in figure 2:
1) formulate a set of proposals to guide the collection of information 2) identify and define specific analytical units 3) conduct a data analysis and interview indicators for the purpose of validating and complementing the proposals for research; 4) carry out individual interview with six open-ended questions and the option of adding follow-up questions in order to gain further insights into selected variables. 5) to generalize the conclusions, triangulate the evidence drawn from each section.

Propositions

The main propositions used in this research are:

1) General - As well as affecting the dairy industry's supply, COVID-19 has also had an impact on the sector's demand for milk.
2) Producers - As a result of the reduction in demand, the disruption of logistical flow, and the restrictions on access to services and inputs, producers have struggled-
3) Processors - Dairy processors have been focused on keeping their plants running, collecting milk on a daily basis, and preventing their workers from contracting the virus.
4) Consumers - Low-income countries have seen their internal demand decline, while middle- and high-income countries have seen theirs rise.
5) Trade - Lower prices and a significant drop in the international trade of dairy products.
6) Government - In the short term, government interventions have been a major driver.

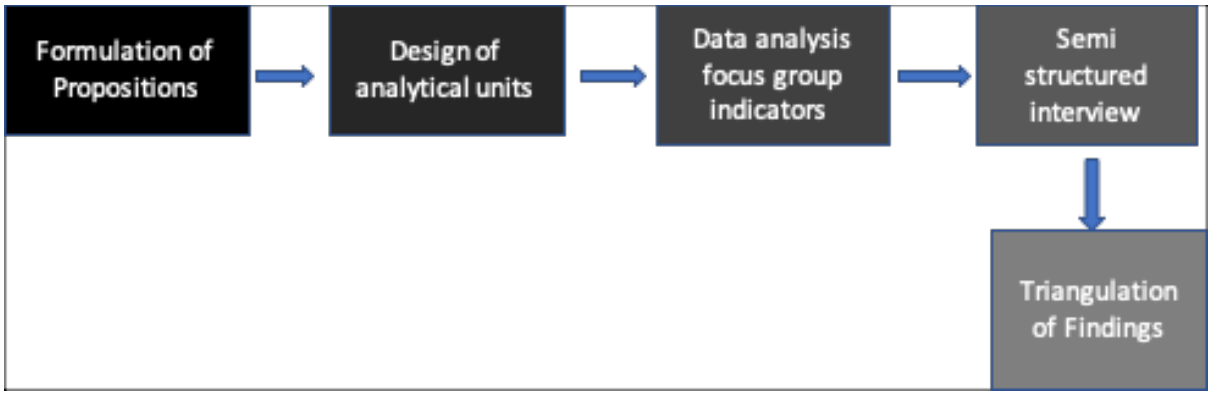

Figure 2: Analytical Framework. Source: Author

A combination of part-productivity and overall factor productivity indices is used for the data analysis. Part of productivity measures are often self-explicit, but Hayami & Ruttan's (1991) literature on technical change is the guiding principle for the selection of specific indicators at farm level. Generally, the study covers all the output of the agricultural industry in Estonia. However specific reference is placed on the dairy sector. Thus, the study highlights the enterprise activities in the Dairy supply chain Sector of Estonia.

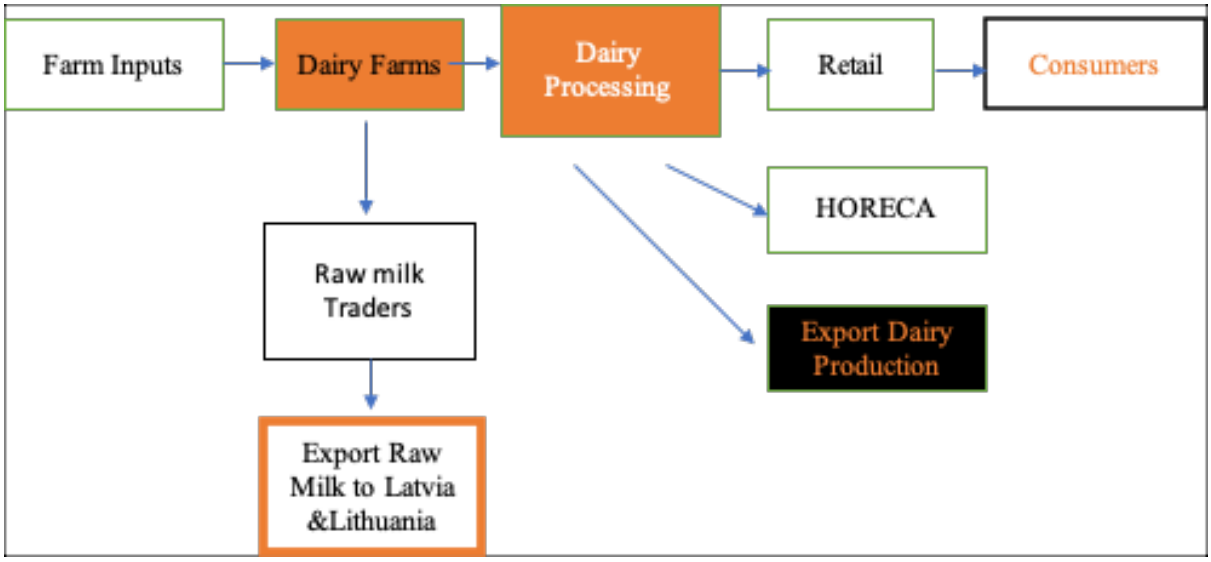

Figure 3: Estonian Dairy Supply Chain. Source: Author

Data used in the analysis of this study was obtained from very reliable sources, mainly the Estonia Statistical database (Statistics Estonia), Eurostat and Eesti Põllumajandusloomade Jõudluskontrolli AS (Estonian Livestock Performance Recording Ltd.). As of August 5, 2020, the interview was held via Zoom online meeting with the Estonian Chamber of Agriculture Chairman. This method of interviewing allowed for a deeper understanding of the dynamic situation resulting from COVID-19 outbreak. Researchers claim that conducting interviews can aid in the understanding of complex processes (Murray et al. 2009). The interview was essential for appending the time-series dimension to the analysis, which allowed the researcher to confirm the data trends and results obtained while distinctly understanding the situation. Based on an extensive review of information, the researcher developed the above-mentioned propositions. These included sectoral analyses and value chain studies, as well as official government reports and newspapers. The following questions were posed:

Question 1 on impact on input supply

- Did the lockdown that happened during the COVID-19 and the closure of borders cause input shortages? if so, what strategies were adopted?

Question 2 on management of the pandemic impacts'

- Were there meetings among stakeholders to agree on a common crisis management strategy?

Question 3

- What was responsible for the dairy farms decrease from (2015-2020)?

Question 4

- How was the communication on crisis management during the COVID-19 pandemic?
- Who was it for?

Question 5

- Did new projects emerge in response to the crisis?

Question 6

- How did the COVID-19 affect foreign trade volumes in the dairy sector in Estonia?

Question 7

- What are the recommendations from the impact of COVID-19 on the Estonian dairy sector?

This will give other researchers a decent chance to play out this study and end up with similar outcomes.

3.2 Data Analysis and Presentation

Trend analysis was used to track changes year on year for selected times in the dairy industry. The dairy supply chain may be considered an open system in which diverse operations under different divisions are carried out. These divisions may be seen as systems of the whole supply chain. Systems of system procedures aim at respecting multi-participant value systems, exploiting complexity via efficient integration and including the environment of unpredictable issues in adaptive response. In order to perform an analysis, it is extremely necessary to identify the relevant indicators. Suitable indicators are key for decisions to meet the supply chain analysis objectives and capture the core of the concepts. The indicators for this framework are identified below;

Table 6: Supply chain segments and indicators

SUPPLY CHAIN SEGMENTS	INDICATORS
Dairy Farms	Number of farms Number of cows Milk Production Milk Purchase Milk yield per cow
Export of raw milk	Price Quantity
Dairy Processing Industry	Total sales (Dairy processing) Value added (profits)
Export of Dairy products	Products Export destinations Quantity Value
Consumers	Domestic demand of Dairy products

Representations like graphs and charts will be used to ensure easy and quick interpretation of data. This method was used because it is the best instrument to identify, compare, describe and reach a conclusion.

4. Presentation and Analysis of Results

4.1 Analysis of The Agricultural Industry and Dairy Sector

In assessing the performance of the agricultural and Dairy industry, the study first considers the overall performance of the agricultural industry in Estonia from 2015 to 2020. The figure 4 below represents the output of the agricultural industry with their respective years for the period of 2015 to 2020.

In the figure 4 below, the study presents total value (in thousand euros) of the output of the agricultural industry. The agricultural industry in general witnessed over 19% decrease from its initial value of 935.1 (million euros) in 2015 to 749.7 in 2016. This deep was followed by a steady but fluctuating increase until 2019 where the value of the total output peaked at 997.6. Again, in the year 2020 the value dropped by about -2.3% to stop at 974.2. From the percentage increase, the lowest point in the performance of the industry in the period understudy was not during the 2020 pandemic but in 2016. According to news report, on the agricultural performance during the year 2016 (https://news.err.ee/585109/estonia-s-agricultural-output-decreases-in-2016), it was noted that the major contributor to the decline in the productivity of the then agricultural sector was the adverse weather conditions which resulted to decreased yields of plant production. The dairy sector on the other hand witnessed an increase in the average milk output in the same period.

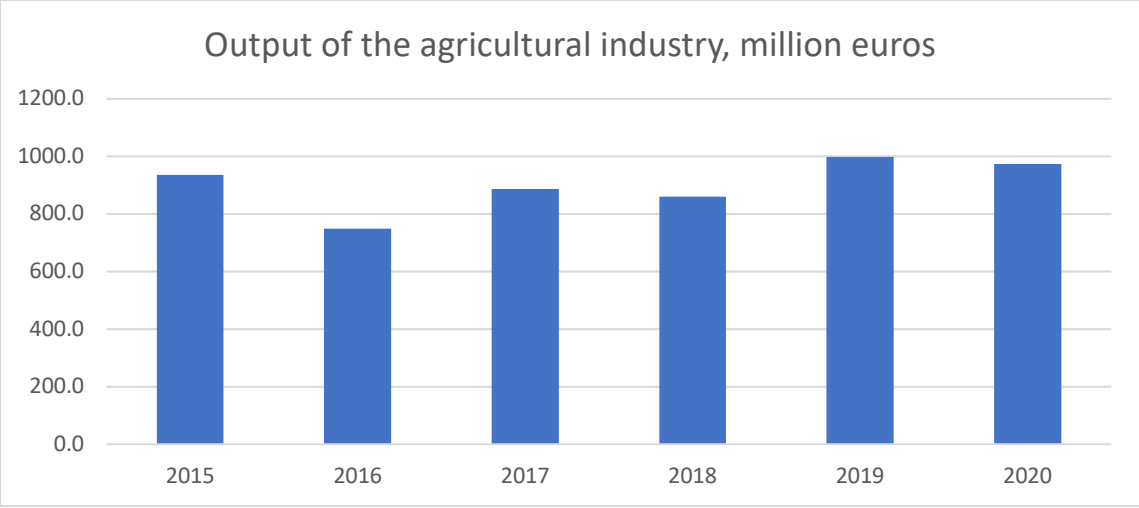

Figure 4: The output of the agricultural industry from 2015-2020. Source: Statistics Estonia

Dairy is also a major export item for Estonian agriculture. According to Sõrmus (Chairman, chamber of agriculture in Estonia), Estonia exported 194.5 million euros worth of milk and dairy products in 2019. Last year, the country's total agricultural output was just over a billion euros, with milk accounting for about a quarter of that. Overall, the dairy industry's growth pattern differed from that of agriculture. Figure 5 below illustrates this. The figure shows that the total output in the dairy sector increased on average from 2015 to 2017, after which it decreased. It is important to note that the gross profit margin in 2020 did not decrease significantly, despite not being the highest during the period under review. The reduction in dairy price in Estonia is in tandem with other reports that there was decline in international dairy prices as measured by the Food and Agricultural organisation (Acosta et al. 2021). Although it decreased by 2.3 percent, the gross profit margin in 2020 showed more stability than decline despite the Covid 19 pandemic as a result of increased demand for and purchases of dairy products during this time period, this could be the case. In assessing the performance of the agricultural Industry and Dairy Sector, the study primarily considers the overall performance of the agricultural industry in Estonia from 2015 to 2020.

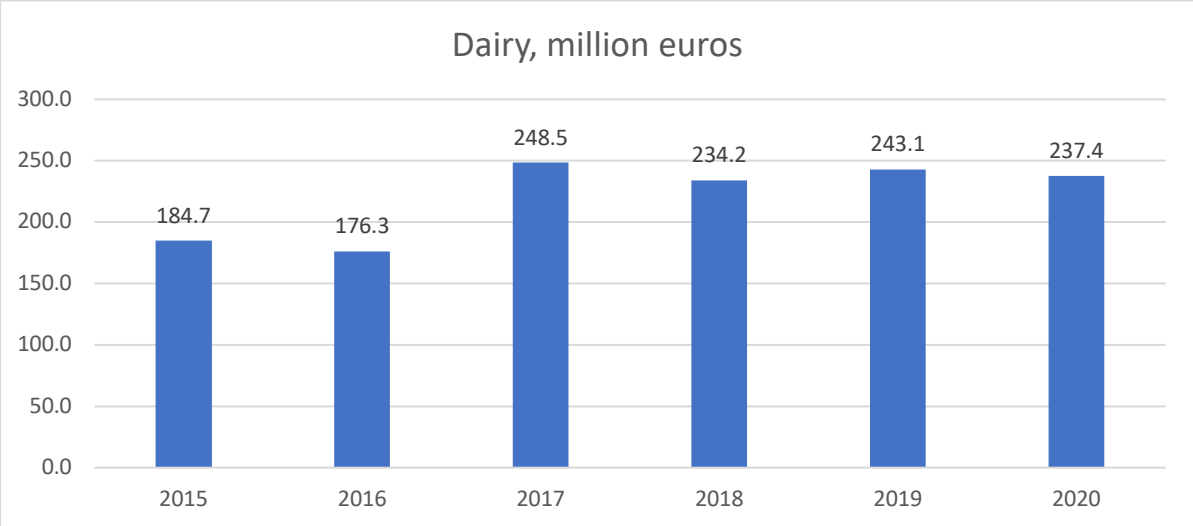

Figure 5: The output of the Dairy industry from 2015-2020. Source: Statistics Estonia

4.2. Analysis Of the Changes Before and Amidst the COVID 19 In the Estonian Dairy Sector

4.2.1. Dairy Farms

The analysis of the impact of COVID-19 on dairy farms relies on the aggregate data provided by the Statistics Estonia Public Database and are categorized under the following variable indicators; Number of farms, Number of cows, Milk Production, Milk Price, Milk yield per cow.

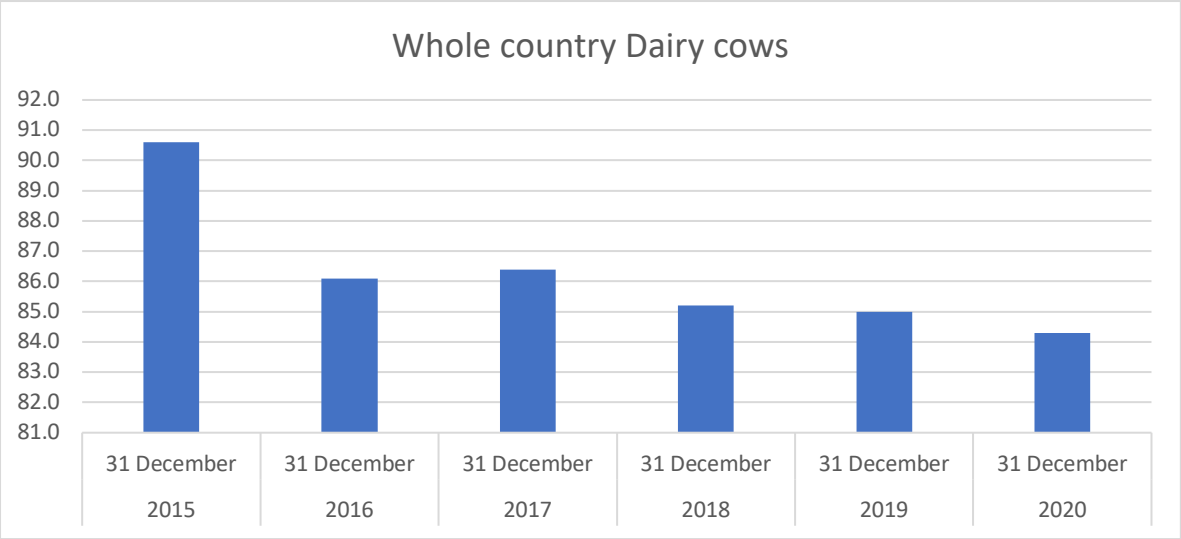

Figure 6: Number of Cows from 2015-2020 in Estonia. Source: Statistics Estonia

Figure 6 shows gives an overview of the changes in a number of cows between 2015 and 2020. It has to be noted that figure 6 is based on the data from statistics Estonia. At the end of 2020, dairy cows numbered 84,300. Compared to the same time a year ago, there was 0.8% more cattle, whereas the number of dairy cows fell. There is a continuing trend that the number of dairy cow's declines. in 2016, there was a 5% decrease in the number of cows from 2015 and consecutively 0.3% increase through 2017 but decreased in 2018 amounting to 85,200 dairy cows and decreased by 0.2% in 2019 before falling by 0,8% in 2020. This is in line with the information obtained during the interview with the chairman of the Chamber of Agriculture who stated that dairy farms in the country decreased because of economic difficulties, a lack on investments into the sector and a lack of replacement to aged farmers.

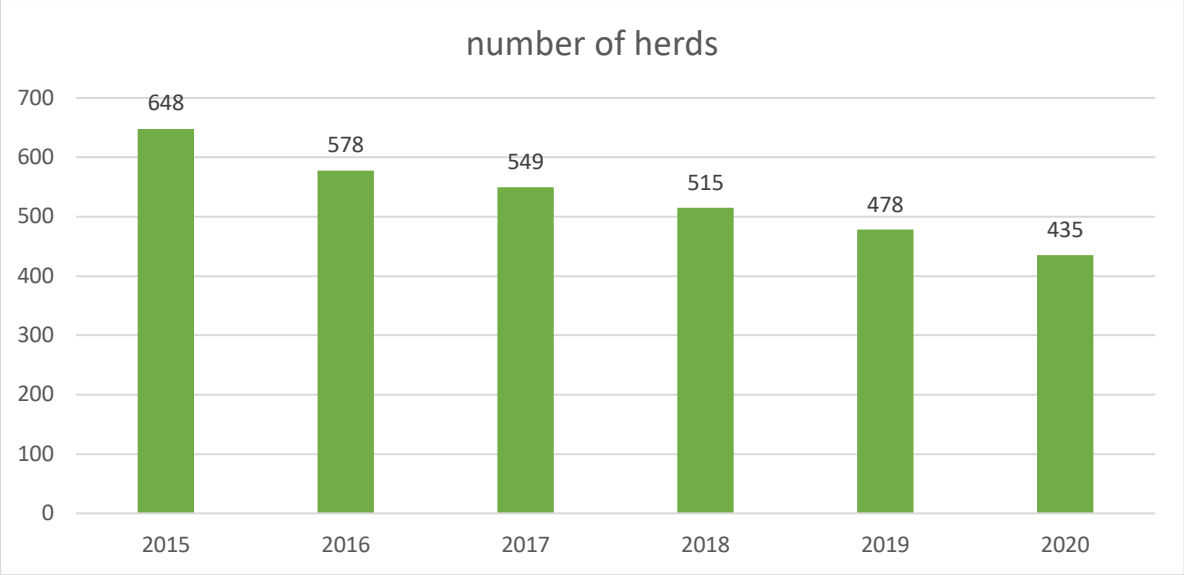

Figure 7: Number of Dairy Farms in Estonia from 2015-2020. Source: Yearbooks of Estonian Livestock Performance Recording Ltd

From figure 7, one can note that the number of dairy herds declined drastically between 2015 and 2020. The decrease has been in large percentages with an 11% decrease from 2015-2016, 5% decrease by 2017, 6% decrease in 2018, 7% decrease in 2019 and in 2020 a 10% decrease, amounting to 435 herds from 648 in 2015. It is possible that farmers were unable to cope with the free market reality of the 1990s, which led to a large decline in herd numbers (Viira et al. 2009, 2014). Statistical evidence from November 2015 suggests that the recent dairy market crisis is continuing to negatively impact small farms.

A provisional estimate of 848 thousand tonnes of raw milk was produced on Estonian farms in 2020, which represents a 3.2% increase from the previous year. It is possible to put this higher level of production in Estonian context by comparing it to production levels in 2017 which was one of the best years in the study period where total amount produced was over 790 thousand tonnes of raw milk and continued to rise even though the number of cows and number of dairy farms decreased and that can be attributed to the steady increase of milk yield per cow as seen in figure 11. This can also be tied to the lack of investments in the dairy sector as stated by the chairman of the chamber of Agriculture in Estonia, causing a couple of dairy firms to close down.

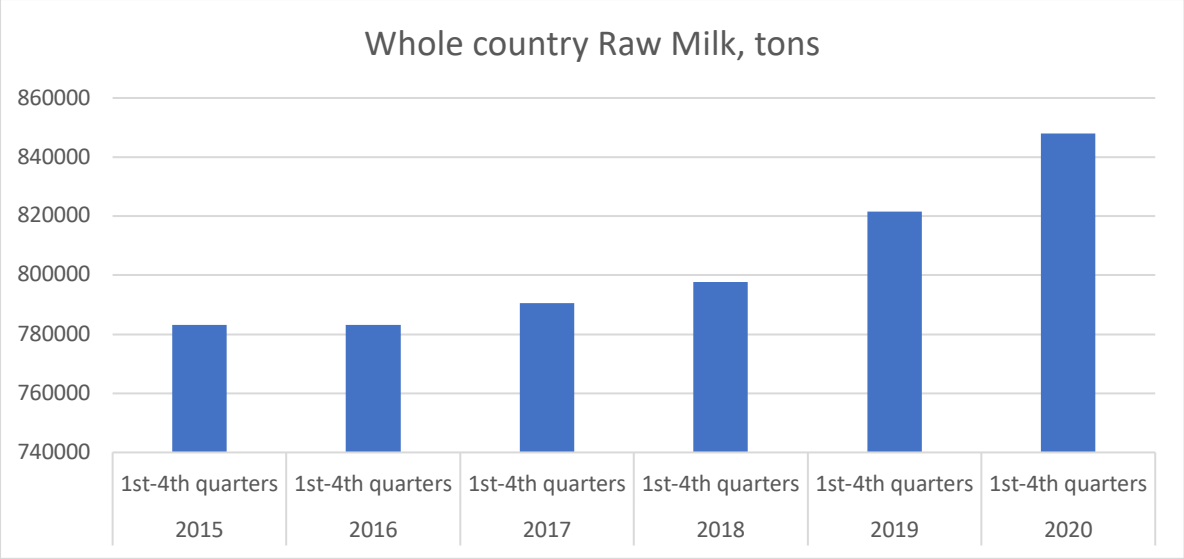

Figure 8: Raw milk production in Estonia 2015-2020. Source: Statistics Estonia

Figure 9 below shows the dairy production in tonnes classed by products in Estonia from 2015-2020. Dairies in Estonia use two-thirds of the whole milk they have on hand to make milk for consumption, cheese and butter and the rest goes to exports. A number of fresh and manufactured products are made from the milk delivered to dairies. Milk products are weighed and listed on the dairy products' labels. This makes comparing the quantities of different products extremely difficult (for example, tonnes of fresh milk and of milk powder). The volume of whole or skimmed milk used in dairy processing does provide quite similar estimates. From the data gathered and analysed, it was evident that there were slight increases and decrease for each product yearly. For drinking milk, in 2016, the production percentage in tonnes increased by 3.9% and consecutively by 1%, 4.5%, 1%, and 1% in 2020 amounting to 106.9 thousand tonnes of drinking milk produced.

Cream production grew by 8.9% in 2016 and then by 6%, 6,2% and then 7% in the following years. In 2020, it decreased by 0.6 percent to 29.3 thousand tonnes of cream. 2016 saw an increase of 3.6 percent, 2017 saw an increase of 1.2 percent, 2018 saw a decrease of the same value, and 2019 saw a decrease of 0.8 percent. In 2020, however, the trend was positive by 1.5 percent. It was noted that in 2016, the total production of butter and other yellow fat dairy products (product group 0403) increased by 1.9 percent, but the following year, the total production fell by 17.3 percent. A 13.9 percent increase in 2018 and a 6.1 percent increase in 2019 were reported. A decrease of 3,8 percent was indeed visible in 2020. Butter with milk fat content (0405) saw no change in production from 2015-2016, but a 16 percent decrease from

2017 to 2018, and an 11.9 percent increase from 2018 to 2019. For cheese, there was a steady increase throughout the years 2015-2020, with 0,5% in 2016, 2,5% in 2017, 0,9% in 2018, 1.5% in 2019 and 1.0% in 2020. Key facts from the interview with the chairman of the chamber of Agriculture also shows that the Estonian dairy sector was able to weather the challenges posed by COVID-19 and hence still fared well just like in India where the production of many small producers helped to mitigate the effects of the shock posed by Covid 19 (Acosta et al. 2021).

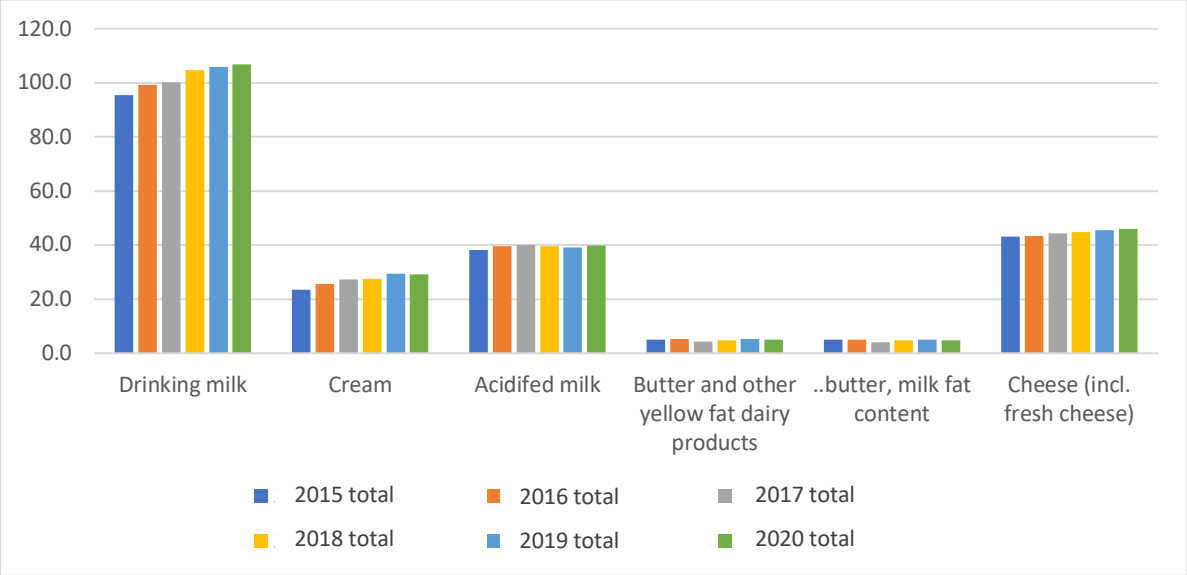

Figure 9: Dairy Production in thousand tonnes classed by products in Estonia from 2015-2020. Source: Statistics Estonia

As seen in figure 10 below, Estonia's milk purchases categorised by average price per ton (in euros) for the period 2015-2020 were such that, for the year 2016, the price fell by only 0.08 percent, but rose by 38 percent the following year. A 6 percent decrease was recorded in 2018 and a 1 percent increase in 2019. By 2020, the milk purchase decreased by 5.4%. The milk purchase declined by 23,7% percent between 2015 and 2020 with highs and lows in between the years. This is line with what happened in the US where milk supply was greater than milk demand resulting into a drop in milk prices, farmers prices also dropped in the UK as a result of low demand (Acosta et al. 2021). From February to December 2020 as seen in table 7 according to the CLAL survey, monthly milk prices in Estonia fell by 5.8 percent, indicating that the pandemic's impact on raw milk prices in Estonia's dairy industry was significant.

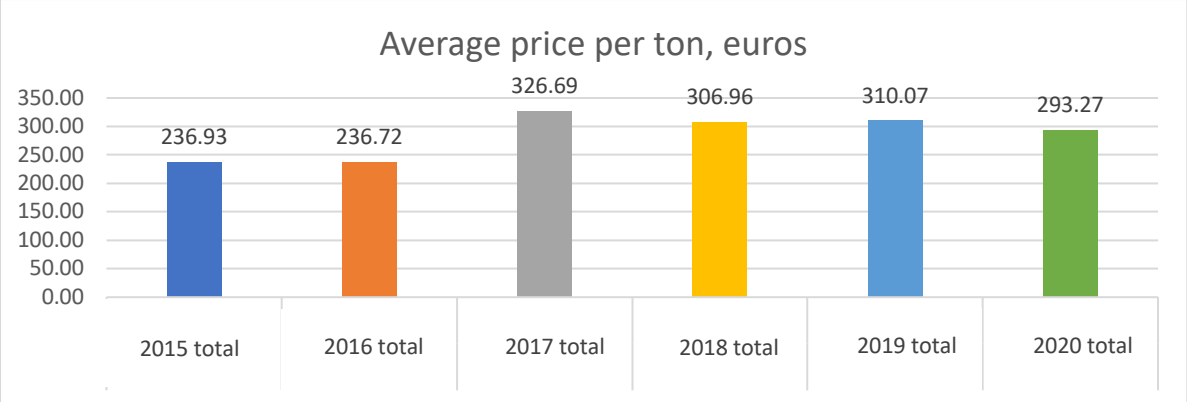

Figure 10: Milk Purchase price in Estonia for the 2015-2020 period. Source: Statistics Estonia

Table 7: Monthly average prices of farm-gate raw milk euro per 0.1 ton in Estonia

Months	2018	2019	2020
January	31,86	31,71	31,30
February	30,24	32,03	31,44
March	29,97	31,57	31,42
April	29,64	31,71	30,35
May	29,23	31,08	28,42
June	29,65	30,47	27,47
July	30,18	30,34	27,71
August	30,34	30,06	27,58
September	31,61	30,30	28,36
October	31,80	30,54	28,90
November	32,29	30,89	29,50
December	32,11	31,32	29,60

Source: CLAL.IT

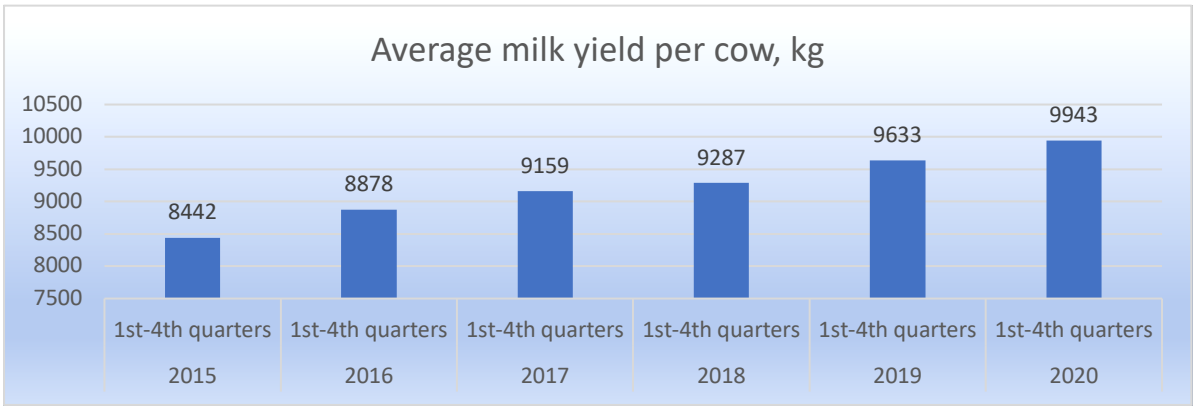

Figure 11: Average Milk Yield Per Cow in Estonia for the 2015-2020 period. Source: Statistics Estonia.

In dairy farms, the most common measure of productivity is the average milk production per cow. Estonia's average annual milk yield per dairy cow grew between 2015 and 2020 by 18 percent. According to Viira et al. (2015), steady growth and high average milk yield has been the pride of the Estonian dairy sector, indicating the high productivity of dairy cows. From figure 10 above, it was evident that there was growth in the average milk yield per cow yearly from 5.1% in 2016 and a positive growth of 3.2% also the following year 2017. Consecutive years from 2018 till 2020 recorded 1.4%, 3.7% and 3.2% positive growth respectively. Currently, the use of the milk in Estonia has become a valuable resource in the manufacturing sector. Cheese, raw milk were significant items of the export of Estonia, where dairy products is processed as raw materials to produce other commodities (Masso and Vahter, 2012). According to the online interview done with the chairman of the chamber of agriculture in Estonia, it was noted that foreign workers from Ukraine were unable to come into the country which disrupted operations at the initial part of the lockdown and it resulted into a shortage of workforce for a couple of months until they were able to get an exemption for the foreign workers to be allowed to come into the country. In a survey of dairy farmers conducted by the Chamber of Agriculture in April 2020, “one in five farm workers, including one in three milkers, are Ukrainian. As a result, a quarter of Estonia's cows are milked by foreign workers". Although**,** according to the agricultural statistics for Estonia, the milk yield per cow has been on a steady increase from 2015 till date figure 11, (Statistics Estonia 2021). Estonian dairy farmers produce roughly 714 000 tons of milk a year, or 2 000 tons a day. The Statistics Estonia (2018) report also shows that over 25% dairy product is exported while the other part is mostly used in the manufacturing sector in the country. The cost of milk is substantially greater in Estonia than in neighbouring Lithuania. According to Joakim Helenius, milk processors often prefer to collect milk from larger farms (as witnessed in Estonia) rather than handle the logistic problems and unfair collecting quality on smaller farms (seen in Lithuania). The collection across dairy farms in Lithuania has to do with reducing costs for the dairy producers. Cost pricing is also good in Estonia as land is still cost-effective. as the price in Estonia ranges from EUR 3,500-4,000 over a hectare of outstanding grade agricultural land compared to €50,000 per hectare in the Netherlands. It is significantly more tempting for investors to add these data if they look at the full picture." This, together with the comparatively favourable milk price, resulted to a value of € 144 million in 2016 for exports of Estonian dairy products (Helenius 2017).

4.3. Comparative Assessment of Quantity and Price Changes Caused by COVID 19 In Dairy Industry

4.3.1. Export of Raw Milk

According to Figure 12, 2017 was the year with the highest export value for raw milk in Estonia. As a result, in 2016 there was a 41 percent value increase, which grew to 52 percent in 2017 - which was the highest recorded during the period under review. This was followed by an 11.3 percent value decline in 2018, an 11% value decrease in 2019 and a 0.2% value decrease in 2020. The value of milk throughout 2019 was higher than that of 2020. At the early stages 2020 before the Estonian government declared a state of emergency in march, the value of milk in 2020 as depicted in the table 7 above was closely related to the prices in 2019. However, the declaration of a state of emergency due to the Covid 19 pandemic in march caused a shift in demand due to unpredictable and dramatic societal changes that lowered the price of milk (Smith 2020). From the figure below it is seen that the rapid fall in the average prices dairy product in the industry extended from March till August 2020 before a retracement began in September. Despite the price recovery effort from September, the average price of dairy product was still lower than that of the previous year. According to Smith (2020) the prices recovery effort was limited because the recent fall in the prices of milk added to the already bad financial conditions of most farmers around the world.

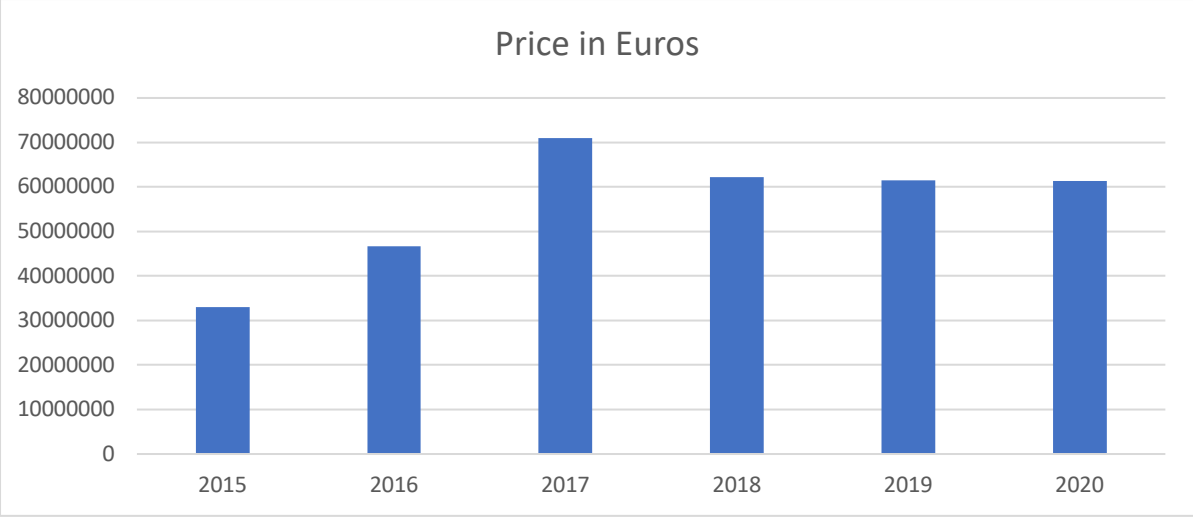

Figure 12: Value of raw milk export in Euros from 2015-2020. Source: Eurostat

The quantity of export in Estonia in 2020 increased the previous year, during the interview with the chairman of the chamber of Agriculture, it was stated that transport restrictions was solved within a short time to allow for the flow of dairy products to other countries, this did not allow the quantity of export from the country's dairy sector to be affected by the pandemic, this is in contrast to other countries in the EU where Acosta et al. (2021) stated that they experienced up to a 24% decline in exports as a result of transportation restrictions.

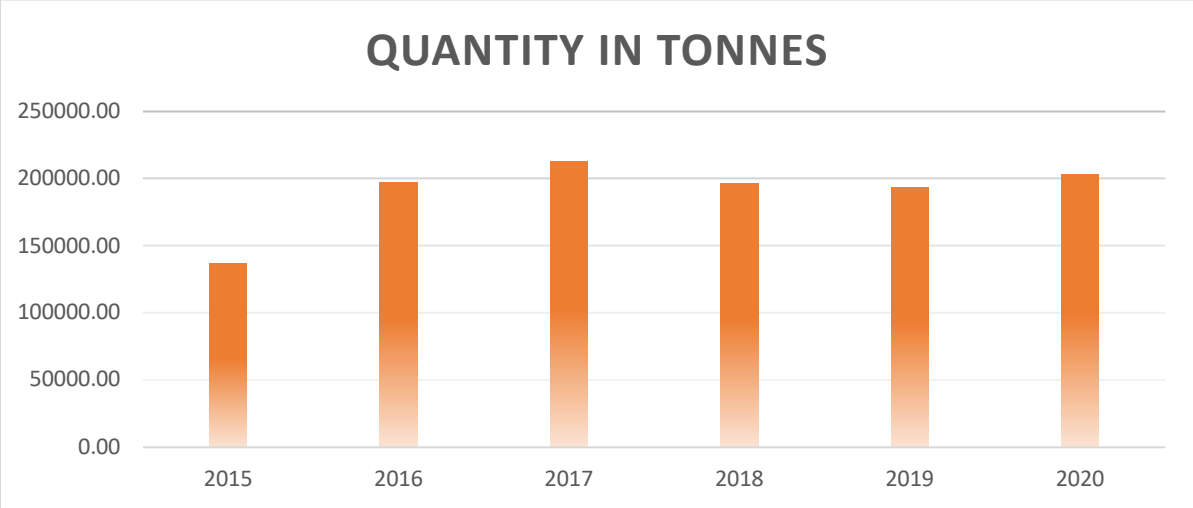

Figure 13: Export quantity in tonnes of raw milk in Estonia from 2015-2020. Source: Eurostat

The Quantity Changes of milk purchased in Estonia between for 2020 is represented in the figure 14 below. From the figure, the quantity of milk purchased was higher in 2020 compared to 2019. This follows the fact that the prices of milk in 2020 was lower, hence the lower the price the higher the demand for milk. In other words, the COVID 19, caused a rapid decrease in the average prices in the sector, as a consequence it led to an increased demand for the product due to the lower prices. This again is in contrast to the demand for milk in the US where demand for fresh milk suffered a decline as a result of the closure of schools and restaurants (Church 2020).

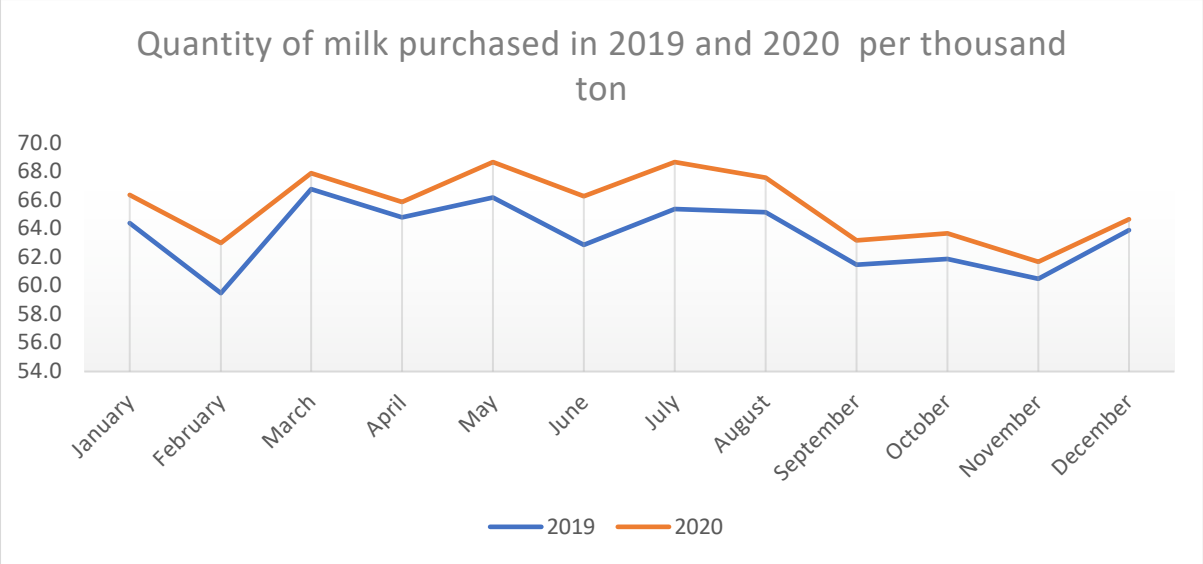

Figure 14: Quantity of raw milk purchased per thousand ton for 2020. Source: Statistics Estonia

Quantities also increased substantially in comparison to export prices and started to decline in 2017 as seen in figure 13, but there was a slight difference in 2020, when quantities increased while prices dropped slightly. 2016 saw a huge 45 percent increase in tonnes; 2017 saw an 8 percent increase; 2018 and 2019 saw a 7.9 percent and 1,4 percent decrease, respectively; and 2020 recorded a 5.1 percent increase as seen in figure 14. The Quantity Changes of raw milk exported in Estonia between 2019 and 2020 follows the fact that the prices of milk in 2020 was lower, hence the lower the price the higher the demand for milk.

On the Quantity and Price Changes caused by COVID 19 in Dairy Sector it was shown that the rapid fall in the average prices dairy product in the industry extended from March till August 2020 before a retracement began in September. Despite the price recovery effort from September, the average price of dairy products was still lower than that of the previous years. On the quantity changes during the period, the quantity of milk purchased was higher in 2020 which follows the fact that the prices of milk in 2020 was lower.

4.4.2 Dairy Processing Industry

Another way to compare dairy production and processing is through growth rates (Jansik et al. 2014). In the figure 15 below, the total turnover for dairy processing and profits were

highlighted and from analysis, in 2016, the turnover rate in euros decreased by 5% leading to a negative decline of 125% in profits but amplified by a large margin in 2017, amounting to a 24.3% increase in turnover and 360% in profits seeming like a good year for processors. In 2018, there was also an increase of 5% in the total turnover but a 27.8% decrease in profits. In 2019, there was a visible 1.8% increase in turnover but a decrease by 33.9% in total profits. At the end of the year 2020, there was a positive increase of 0.8% turnover and 35.6% increase in profits. Overall, from 2015-2020, there was an increase of 27,2% in total turnover but a decrease of 23.4% during that period. Though there was a reduction in the quantity of turnover realised from dairy processing in Estonia, it however was able to withstand the shocks from the pandemic in Africa, it was stated that in Kenya labour movements and transportation restrictions caused a reduction in the processing output of their processing plants (Acosta et al. 2021).

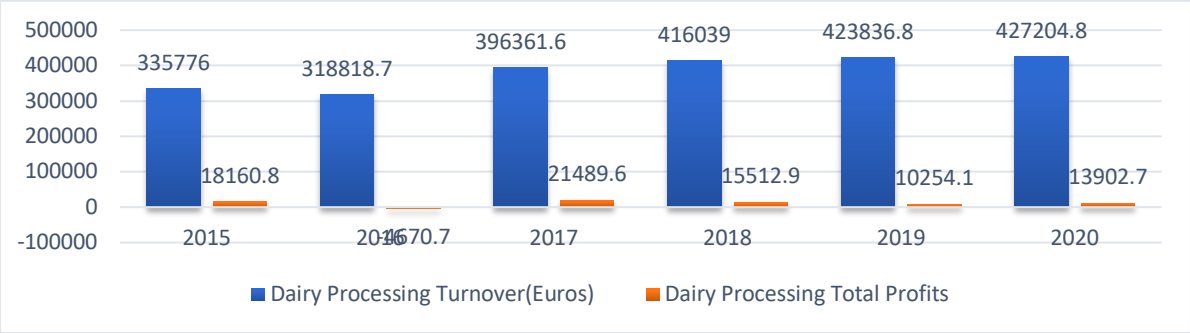

Figure 15: Total Turnover of Dairy Processing and Profits from 2015-2020 in Estonia. Source: Statistics Estonia

4.4.3 Export of Dairy Products

The main groups of export dairy products in Estonia are concentrated milk and cream, i.e., skim milk powder and whole milk powder (Combined Nomenclature (CN) code 0402) and Cheese (0406). From 2001 onwards, the share of cheese (0406) in export turnover started to increase until 2009 (Viira et al., 2015).

0401- Milk and cream, not concentrated nor containing added sugar or other sweetening matter
0402- Milk and cream, concentrated or containing added sugar or other sweetening matter
0403- Buttermilk, curdled milk and cream, yogurt, kephir
0404- Whey, whether or not concentrated or containing added sugar or other sweetening matter

0405- Butter and other fats and oils derived from milk; dairy spreads

0406- Cheese and curd

According to Statistics Estonia database 2021, Top export destinations of “dairy products and other fats and oil derived from milk; dairy spreads." from Estonia in 2020 are Latvia, Lithuania, Netherlands, Norway, Japan, Ukraine, Italy, Finland, Poland. The dairy products trade with the rest of the countries observed is less significant, as the amount exported is relatively small, but not negligible. As seen in the figures below, Latvia, Finland, Netherlands and Lithuania are the major destinations of dairy products from Estonia and that varies on the type of products.

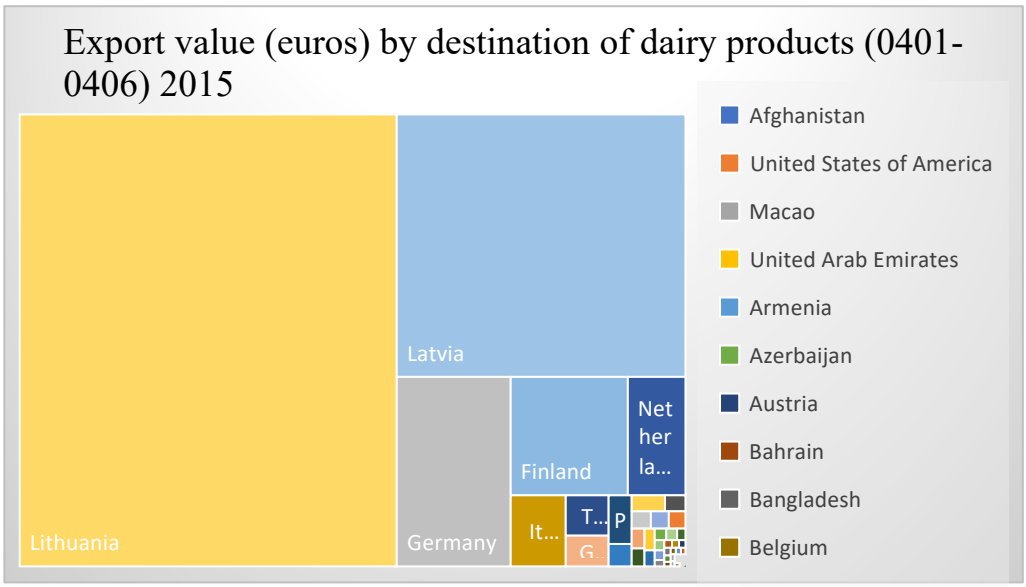

Figure 16: Export values in euros by destinations of dairy products (0401-0406) from 2015.Source: Statistics Estonia

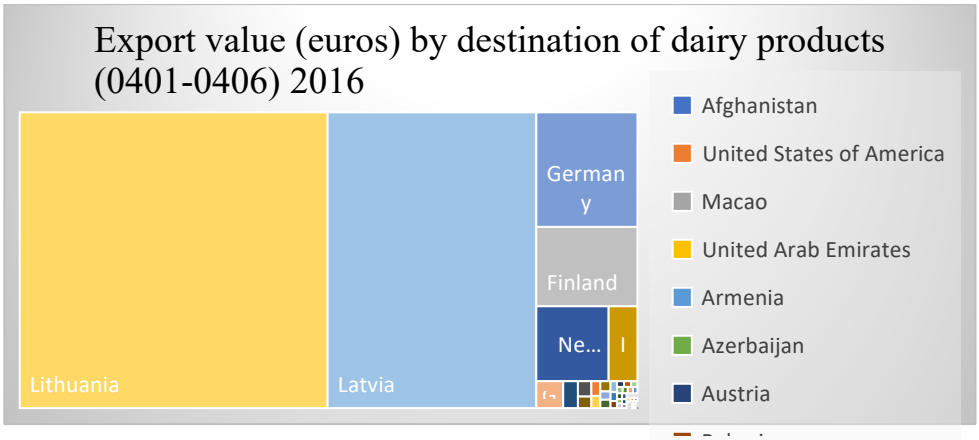

Figure 17: Export values in euros by destinations of dairy products (0401-0406) from 2016.Source: Statistics Estonia

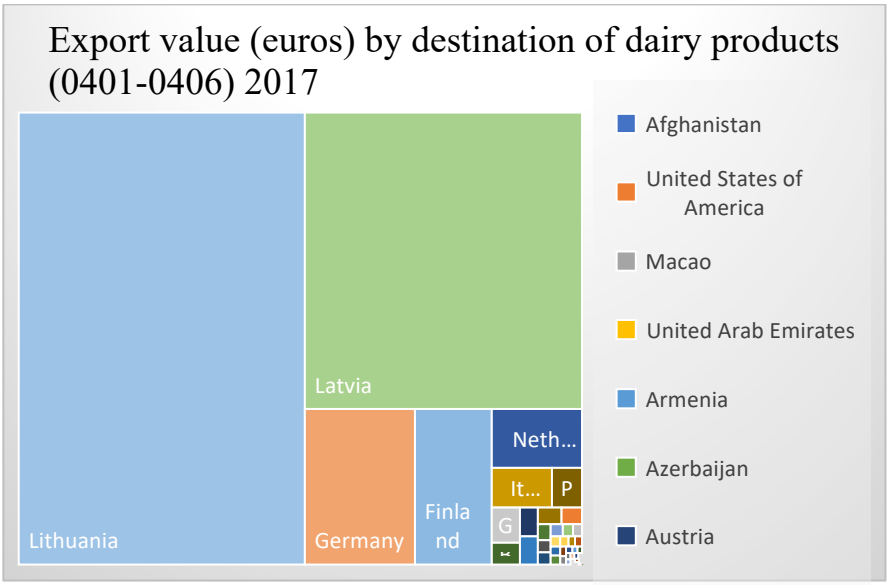

Figure 18: Export values in euros by destinations of dairy products (0401-0406) from 2017.

Source: Statistics Estonia

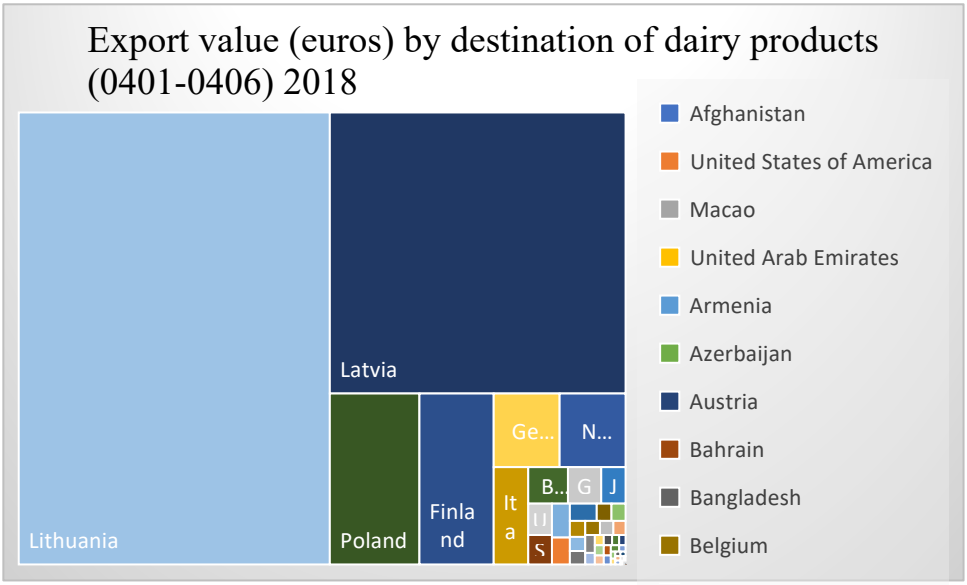

Figure 19: Export values in euros by destinations of dairy products (0401-0406) from 2018

Source: Statistics Estonia

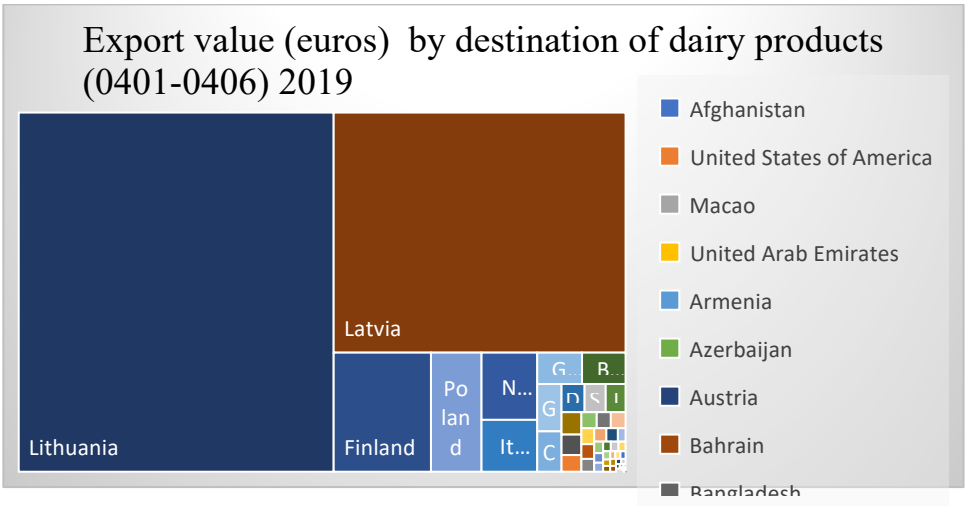

Figure 20: Export values in euros by destinations of dairy products (0401-0406) from 2019. Source: Statistics Estonia

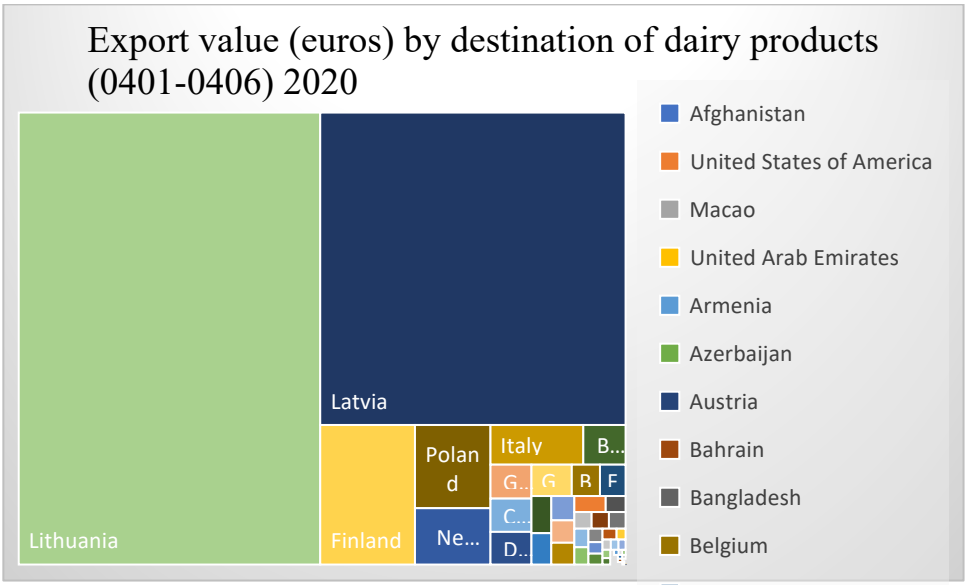

Figure 21: Export values in euros by destinations of dairy products (0401-0406) from 2020 Source: Statistics Estonia

The above trend can be partially explained by changes in the main export destinations for Estonian dairy products in world trade as shown in Figures 16-21. As of 2015, the average share of dairy products exported to Lithuania was above 33 percent, but it dropped to 24 percent by 2020. As of 2019, Latvia was the second-largest export destination, with a 19 percent share of total exports. Finland and the Netherlands saw a decline in the percentage share of export quantity in 2019 and 2020, according to the data researched. A new shift in the structure of export destinations occurred after the EU's 2004 accession, according to Viira et al. (2015) Russian dairy exports began to increase as the Russian market opened up again. As of 2014,

the share of Latvia, Lithuania, and Finland has also begun to rise. A significant drop occurred in the number of export destinations in 2014. Seventy-six percent of the total exports of dairy products were sent to Lithuania, Latvia, Finland, and Russia.

Disasters such as the COVID-19 pandemic represent a turning point in the development of the dairy industry in Estonia. The dairy sector adapted to changing institutions, agricultural policy, and markets at the start of 2020, as has been the case with each previous crisis that has occurred. "The Minister of Agriculture of Lithuania has assured us that dairy industries in Lithuania will continue to accept Estonian dairy," reads a report from the ministry of rural affairs (2020)". All dairy batches – not just imported dairy – will continue to be monitored. As a result, Lithuanian consumers continue to purchase Estonian dairy products. Export markets were reoriented as a result of a change in the institutional and policy context brought about by EU membership. As a result of the 2009 dairy crisis, raw milk was exported to other Baltic States. Because of this, the dairy sector in Estonia has been able to adapt to changing conditions despite the fact that the COVID-19 had an impact on the demand for dairy products. In accordance to Viira et.al. (2015), dairy farms have a greater ability to adjust average production costs and production volume in response to market conditions.

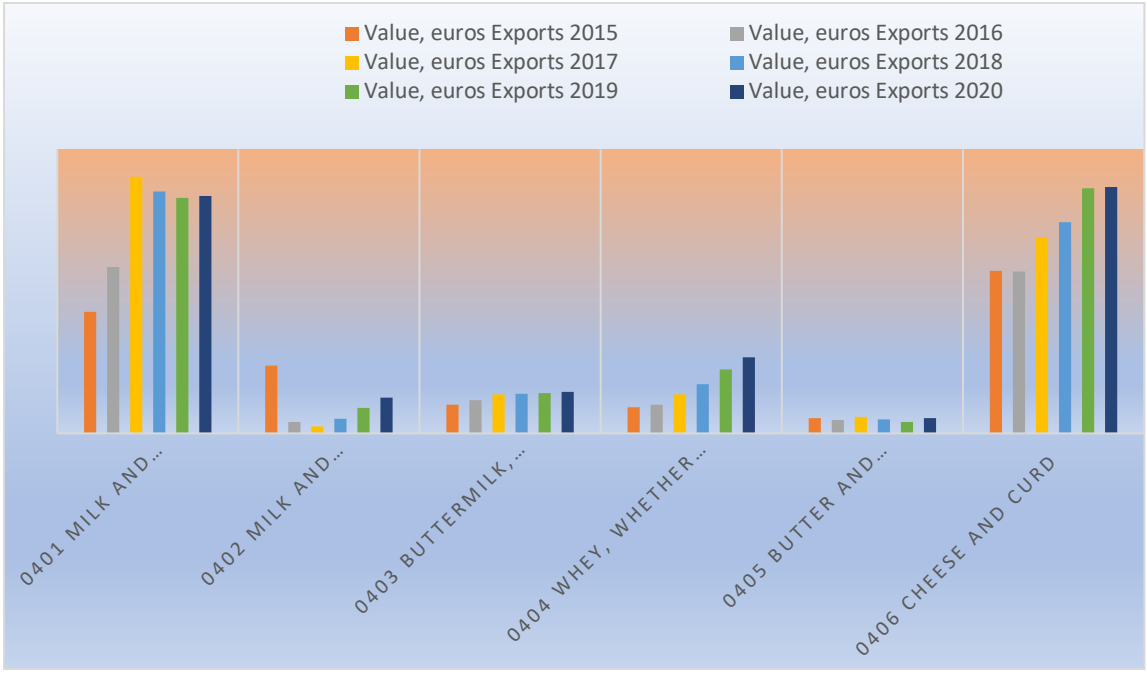

Figure 22: Value of exports for dairy products value in Euros (CN codes 0401-0406). Source: Statistics Estonia

A unique set of characteristics defines demand and supply for dairy products, which is reflected in the diversity of export trade performance. According to viira et al. (2015), In recent years, the structure of export products and markets has undergone several changes. Dairy exports are highly competitive in Estonia because of their ability to adapt to changing conditions in export markets. An analysis of the study focus period revealed that there were variations in percentages based on product group, which means that some products were demanded and exported than others. From figure 22 above, it could be seen that in 2016, the exported value in euros of non-concentrated milk and cream (0401) rose by 36.7%, in 2017 by 54.3% which was the highest during this study period. And in 2018 and 2019, reduced by 5.9% and 2.5% before increasing by 0.87% in 2020. On the other hand, sweetened milk and cream (0402) saw a decline for two consecutive years 2016 and 2017 with 83% and 41.4% respectively before rising by 122% in 2018 and continued to increase in the latter years 2019 and 2020 by 69.4% and 41%.

For buttermilk, curdled milk and cream, yogurt, kephir (0403), throughout the years 2015-2020, there was a positive increase in the price of the products exported. in 2016, there was a 16.6% increase, in 2017, there was a 16.4% increase, in 2018 and 2019, there was 1.87% and 2% increase respectively and at the end of 2020, there was a 2.4% increase in the price of products exported in this category. Similarly, to 0403, the product whey (0404) saw a positive increase in the prices from 9.8% in 2016 to 35.6% in 2017, 25% in 2018, 30.4% in 2019 and 19.3% in 2020.

A decrease of 9.25 percent in 2016 from 2015 was recorded for butter and other fats and oils from milk; dairy spreads (0405), but the price increased by 22.8 percent in 2017 before decreasing by 16.1 percent each in 2018 and 2019 before increasing again in 2020 with a 36 percent increase. Cheese, and curd (0406) saw a 0.14 percent decline in 2016 but a 52 percent increase from 2017 to 2020. It was 20.8 percent in 2018, 16.1 percent in 2019, and a minute 0.66 percent in 2020.

In 2016, the export quantity of non-concentrated milk and cream (0401) increased by 40.1 percent, in 2017 by 10.1 percent, and in 2018 and 2019, it decreased by 5.4 percent and 1.4 percent, respectively, before increasing by 4.6 percent in 2020. Figure 23 illustrates this trend. Two years in a row sweetened milk and cream (0402) fell by 83.6 percent, then by 80.7 percent in 2017, before rising by a massive 164.5 percent in 2018 and continuing to rise by 25.7 and

30.5 percent in 2019 and 2020. A positive trend was observed for buttermilk, curdled milk, yogurt, and kephir (0403), from 2015 to 2020, with the exception of 2018, which saw a 0.77 percent decline. A 31.2% rise in 2016; a 9.7% rise in 2017; a 4.5 percent increase each year in 2019 and 2020; an average of 2.5% growth. Similarly, to 0403, the product whey (0404) saw a positive increase in the quantity exported without a decline. From 12.4% in 2016 to 3.66% in 2017, 10.5% in 2018, 11% in 2019 and 7% in 2020. A decrease of 2.6 percent in 2016 from 2015 was recorded for butter and other fats and oils from milk; dairy spreads (0405), and the quantities dropped further till 2019 with 27.1 percent in 2017, by 18.6 and 6.2 percent each in 2018 and 2019 before increasing again in 2020 with a huge 58.7 percent increase. Cheese, and curd (0406) saw a positive trend of increase throughout this period. It was recorded that 4 percent was exported in 2016, 5.1 percent in 2017, 9.5% in 2018, 9.62% in 2019 and 4.67% in 2020.

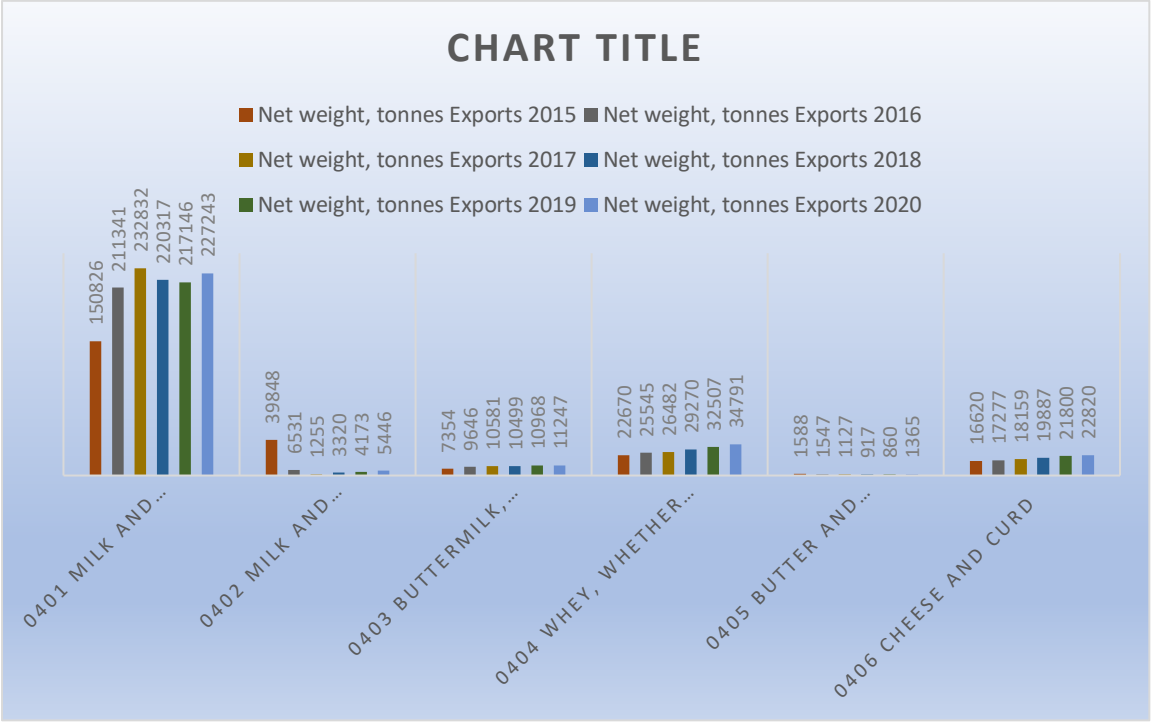

Figure 23: Exports of dairy products Quantity in tonnes. Source: Statistics Estonia

4.4.4 Effect on Human Consumption of Dairy Products

Another factor that affects the food supply chain is constant change in demand. In particular, essential products for daily life, such as disinfectants and food, have become more in demand

at the beginning of the outbreak (Donnay 2020). However, the perishable nature of food makes it more susceptible to the impact of COVID-19 in the supply chain. In this way, it is important to assess the income of and sales revenue of manufacturer in the dairy industry. Such analysis is expected to show the if the supply and demand disruptions due to the COVID-19 outbreak affected the overall sales revenue during the time under review. With these results, production, processing and distribution can be adapted accordingly. From figure 16 which represents the domestic demand quantity of dairy products in tonnes from 2015 till 2020, it could be identified that although the COVID 19 pandemic slowed down productive activities in 2020, the difference in domestic demands for milk and cheese was not far apart but varied by product type.

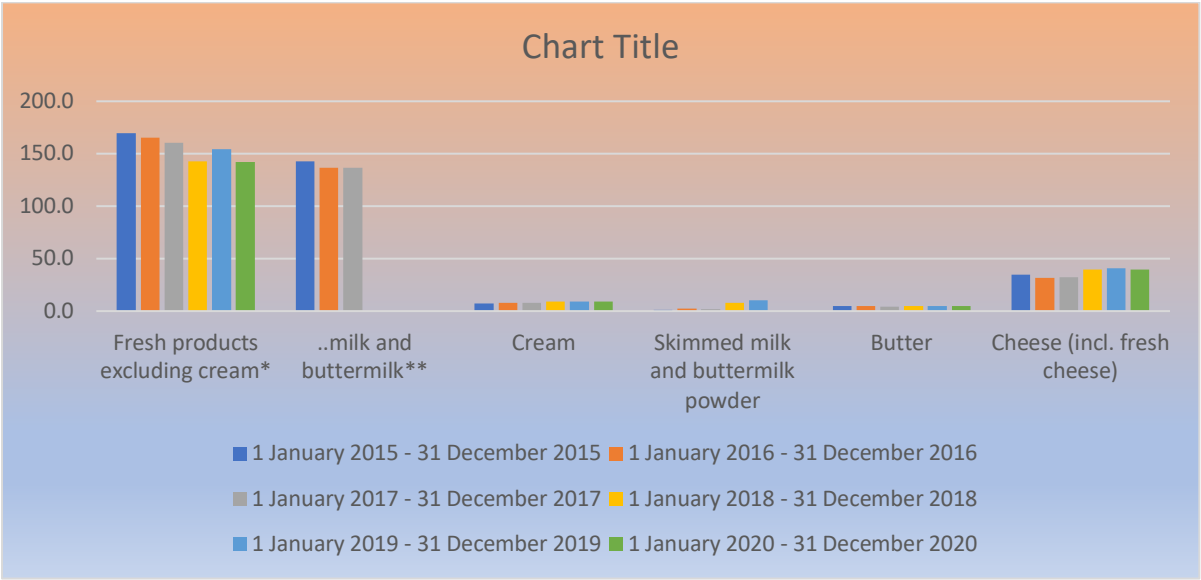

Figure 24: Domestic demand of dairy products in tonnes. Source: Statistics Estonia

From figure 24 above, the demand for fresh dairy products declined by 2.2% in 2016, continued to decrease in 2017 by 3.0% and also in 2018 by 11% but increased in 2019 by 8.2% before finally decreasing in 2020 by 7.9%. For cheese, the quantity dropped by 9.7% in 2016 from 2015, but increased by 2.9% in 2017, 22,6% in 2018, 3.0% in 2019 but decreased by 2.5% in 2020 which was the year COVID-19 became protuberant in Estonia. for cream, there was positive demand till 2019 ranging from 6.8%, 2.5%, 8.6%, 2.3% respectively, but in the year 2020 when covid became a factor, it decreased by 2.3%. For butter, there was recorded 2.1% increase in 2016, but the following year, there was a decline of 6.3% which changed in the following years 2018 and 2019 with a positive 13.6% increase and 2% but declined by 2% in

2020. This is in contrast with report by (Acosta et al. 2021) that there was an increase in demand for fresh dairy products in Europe. Not only Estonia suffered a decrease in demand for dairy products, there was also a decrease in the demand for dairy products in the US from 0.8% to 0.5% (Byington, 2020). Sales of cheese and yoghurt also dropped in Brazil (Acosta et al. 2021). In the US, it was recorded that most of the usual markets for fresh milk such as hotels, cafes, restaurants, schools were closed down and this almost led the US farmers into a crisis (Huffstutter 2020).

5. Discussion of Findings and Conclusion

5.1. What Are the Impacts on Domestic Demand and Supply of Milk and Cheese Production Amidst the COVID 19 Pandemic?

When "stay at home" orders were issued, sales of milk and other dairy products by individual households increased dramatically. Because so many people rushed to the grocery store in the early stages of this pandemic, many shelves were empty by mid-March in 2020. When many households began ordering food online, purchases of milk and other dairy products, such as ice cream and yogurt, dropped significantly. Buying milk and most dairy products online for home delivery is difficult from a practical standpoint (WANG Qingbin et al. 2020). It is clear from Figure 25 that in 2020, the demand for milk and other dairy products declined slightly. Many factors might have contributed to this drop in demand including school closings, restaurant closures, hotel closures, and many other business closures, as well as restrictions on tourism, which may have contributed to the drop in domestic dairy consumption. The supply of dairy production (milk and cheese) between 2019 and 2020 was the highest in 2019 and with a 2.3% decline in 2020 during the COVID-19 pandemic (See Figure 4 and 5) which is just the same as the supply of agricultural products during this period though there was a steady increase in average milk yield, it implies that the supply of milk and cheese was not really influenced by the COVID-19 pandemic. Also, the general trend of reduction in the number of cows and number of herds from 2015-2020 makes it difficult to attribute the supply of milk and cheese to the COVID-19 pandemic (Figure 6). The data on the different dairy product (See Figure 9) shows a steady increase drinking milk production, cheese production, acidified milk and a slight decrease in cream, butter milk and fat contents also make it difficult to attribute changes in milk and cheese supply to the COVID-19 pandemic.

During the pandemic dairy milk and cheese production increased, milk yield increased, cream, butter milk and fat contents and cream production decreased, number of cows and number of herds also decreased. From (figure 25) domestic demands of dairy products in Estonia witnessed a decrease during the pandemic between 2019 and 2020 for fresh products (excluding cream) butter, cream and cheese while there was an increase was observed for only for skimmed milk and butter milk powder. The US, just like in Estonia (Huson 2020), the

demand for milk decreased by 12-15 percent, it was also stated that the aftermath of the pandemic was seen in that 90% of the cheese market in the US disappeared. In other countries it was noted that there was a rise in demand for fresh products in Europe for products as mozzarella cheese, cream and butter (Acosta et al. 2021), this author also stated that dairy products such as milk, yoghurt and cheese were in high demand in Mexico.

5.2. How Did the Pandemic Impact Dairy Products Prices and Quantities?

In Estonia, the farmgate prices for milk depend on how the milk is used among four distinct objections: Class I covers milk utilized for liquid or drink milk items and gets the greatest cost, Class II alludes to drain going into "delicate" made items like sharp cream, curds, frozen yogurt, and yogurt, Class III incorporates milk utilized for making hard cheeses, and Class IV milk is utilized to make spread and dry items like non-fat dry milk (NFDM) and gets the most minimal value (CLAL 2019). Milk price was the lowest in 2020 between 2017 and 2020 which can be due to a reduction in demand during the COVID-19 pandemic, milk yield however continued to increase. Results displayed in Figure 9 indicates that there was an increase in the quantity of drinking milk, cheese, acidified milk produced during the pandemic, there was however a slight decrease in the quantity of cream, butter, milk fat content and butter and other yellow fat dairy products produced in the nation. The data on the indicators of export of raw milk are price and quantity revealed that there was a trend of decline in the price of raw milk between 2017 up until 2020, the extent of reduction in price between 2019 and 2020 was the smallest, which makes it difficult to trace the reduction in price between 2019 and 2020 and relate solely to the pandemic. All of which must have resulted into a reduction in profitability of the farmers and processing industries. As can be seen in figures 13 and 15 above, raw milk sales to processors were also adversely affected. The price per ton of raw milk fell sharply in march 2020, but the quantity increased, indicating that raw milk producers must have been affected by the price drop. It was however stated that the government provided some loans and credits for rural enterprises which also must have helped certain rural firms to continue production and hence the effects of the pandemic were mitigated. During the interview with the Estonian chairman, chamber of Agriculture, it was stated that prices of dairy products dropped at the beginning of Corona crisis. Stephenson and Shutske (2020) also stated that dairy farmers saw a decrease in

dairy prices as a result of the corona virus epidemic caused by worldwide market pricing, shutdown of workplaces, hotels, restaurants, cafes and schools.

5.3. How Did the COVID-19 Affect Foreign Trade Volumes in The Dairy Sector in Estonia?

In Estonia, there are four main destinations for milk and dairy products produced such as; households via grocery stores and online purchases, schools via subsidised purchasing, Bulk purchases are made by restaurants, hotels, and other businesses and organizations, and exports which are made to foreign markets. Estonia is the largest and most productive milk producer in the Baltics, with a total milk production of 848 thousand tons in 2020 (Statistics Estonia 2021). The quantity of milk in tonnes in Estonia displayed in Figure 11 shows an increase between 2015 and 2017, followed by a decrease between the end of 2017 and 2019 and an increase between 2019 and 2020, the increase in the demand for milk and the subsequent reduction in price in this period is traceable to the pandemic which must have led to decrease in price sighting the fact there was lockdown and some amount of people from different countries in the world suffered a reduction in income in this period, people must have also increased their demand for milk sighting the unpredictable nature of the pandemic as a reason to store up food for their survival.

During the pandemic, there was an increase in the value of exports for all the dairy products in Estonia, even though some products were witnessed a greater amount of increase in export value than others. As a result of the significant decline in demand for bulk purchases, many processors with processing lines designed exclusively for bulk destinations faced major difficulties. Figures 23 and 24 show that despite disruptions in international trade and transportation caused by the pandemic, Estonia's exports of dairy products increased significantly in total value and aggregate volume in 2020 compared to the same period in 2019. Estonia has seen a drastic drop in the amount of cheese exported to Italy for example, as a consequence of the closure of its borders which prevented tourists from visiting and the closure of HORECA services (hotels, restaurants, and cafes). Having already noted that adaptation to changing conditions in export markets is a major characteristic of the Estonian market, it was obvious that it was able to thrive well in spite of the restrictions the pandemic could have posed as it was stated during the interview with the Chairman of the Chambers of Agriculture that the

lockdown initially caused a barrier in the transportation of products across borders for export, but this was however solved quickly. It was also stated that price of exported dairy products had also reduced.

5.4. What Are the Recommendations from The Impact Of COVID-19 On the Estonian Dairy Sector?

While the COVID-19 pandemic has greatly affected dairy industries around the world, the study has accessed the impact of the pandemic on dairy industries in Estonia. It without doubt that the dairy industry in Estonia would have thrived better without the pandemic

Recommendations

- **Training and empowerment:** young people need to be trained and empowered with funds in order to encourage them get involved in the dairy sector and also to see to it that abandoned dairy farms are revitalized for the resumption of operations.

- **Financing of the dairy sector:** the dairy sector in Estonia needs finances pumped into it, supply chains have to be revived such that the problem of decline in the number of dairy farms can be a thing of the past. More dairy farms need established to boost the production of more dairy products, which will be a source of employment for people in the country and also serve as medium of foreign exchange. This will also encourage young people to engage themselves in the dairy sector in the nation.

- **Risk management policy:** the government needs to work had in hand with the management of dairy farms to be able to setup a flexible risk management policy that will help the dairy industry to not only adapt but also to thrive in any period of crisis, to prevent wastage of products and not to disrupt production lines.

- **Establishment of dairy processing firms:** it was noted that during the early part of the COVID-19 pandemic as a result of border closure it was difficult to get products across to processing firms in neighbouring countries, all of this could have been avoided if there are sufficient processing firms in the country, also a lot of money which could have been realized

as income to the dairy sector will be lost to other countries where the dairy products are being processed. The establishment of dairy processing firms will also boost the demand for dairy products in the country.

5.5. Conclusion

The study generally seeks to analyse the impact of COVID-19 on the dairy supply chain in Estonia. This research examined the Estonian dairy supply chain under various variables and indicators in Estonia and analysed the impact on quantity and price changes on dairy products, domestic demand, export trade volumes, profit and the return to labour in the processing of dairy to provide recommendations. The objective of the study was to assess economic effects on the operational performance of supply chain actors in the industry, the quantity and price changes caused by COVID 19 pandemic in the Estonia dairy supply chain and the Supply Chain Risk and Uncertainty caused by COVID 19 pandemic. To achieve this the study was motivated to examine the trend of the agricultural and dairy industry performance, provide a Comparative assessment of quantity and price changes caused by COVID 19 in dairy industry and provide a detailed assessment of the economic activities in the dairy supply chain before and during the pandemic. Beyond the statistical estimation of the impact of COVID 19 on the various actors of the dairy product supply chain, it is important to highlight other factors that constitute supply chain risk and uncertainties during the pandemic, and this was buttressed with an online interview held with a stakeholder in the Estonian dairy sector.

In accordance with one of the set objectives, which is to examine the impact of domestic demand and supply of dairy products (milk and cheese) in the context of the covid 19 pandemic, it was found that domestic demand for these products from 2015-2020 has been declining. School closings, restaurant closures, hotel closures, and many other business closures, as well as restrictions on tourism, may have contributed to the drop in domestic dairy consumption. With comparison to the rest of the world, in the United States, as in Estonia, the demand for milk fell by 12-15 percent (Huson 2020). It was also reported that 90 percent of the cheese market in the United States disappeared as a result of the pandemic. During the COVID-19 pandemic, dairy production (milk and cheese) reached its highest level in 2019 and fell by 2.3 percent in 2020. (See Figure 4 and 5) While there was a steady increase in milk yield during

this time, it appears that the COVID-19 pandemic had little impact on the supply of milk and cheese.

Secondly, the study examined the impact on dairy products prices and quantities. Results displayed indicates that there was an increase in the quantity of drinking milk, cheese, acidified milk produced during the pandemic, there was however a slight decrease in the quantity of cream, butter, milk fat content and butter and other yellow fat dairy products produced in the nation. The data on the indicators of export of raw milk are price and quantity revealed that there was a trend of decline in the price of raw milk between 2017 up until 2020, the extent of reduction in price between 2019 and 2020 was the smallest, which makes it difficult to trace the reduction in price between 2019 and 2020 and relate solely to the pandemic. All of which must have resulted into a reduction in profitability of the farmers and processing industries.

According to a study by Ivanov (2020), the most vulnerable driver in a pandemic is demand disruption, as it is the driving force behind any Supply Chain, and if it is disrupted, it could lead to the failure of the entire system. From an interview with the chairman of the Estonian chamber of agriculture, it was noted that there was no supplier reduction in Estonia which could also be noted in figures 23 and 24 in the data analysis of dairy products exports, and no milk was dumped during the pandemic. During the pandemic, there was an increase in the value of exports for all the dairy products in Estonia, even though some products were witnessed a greater amount of increase in export value than others. As a result of the significant decline in demand for bulk purchases, many processors with processing lines designed exclusively for bulk destinations faced major difficulties. Figures 23 and 24 show that despite disruptions in international trade and transportation caused by the pandemic, Estonia's exports of dairy products increased significantly in total value and aggregate volume in 2020 compared to the same period in 2019. Another significant driver in a pandemic situation with regards to supply chain risks and uncertainty is stoppage of production (Ivanov 2020). This driver which also should have a considerable impact on the business of firms didn't really affect much in Estonia, as the average milk yield per cow for the year 2020 saw an increase despite the shortage of dairy production workers from Ukraine.

Overall, there seems to be a slight but not cataclysmic impact on the dairy supply chain in Estonia but doesn’t exclude the fact that the dairy sector would have thrived better without the COVID-19 pandemic. However, this is a wakeup call not for only the dairy sector in Estonia,

but other Agri-food sectors to plan and implement proper risk management tools and policies, peradventure similar or worse crises emerges in the nearest future.

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APPENDIX 1

Interview Questions

Evolution of supply chain in enhancing local agribusiness amidst the COVID-19 in Estonia (a case study of the dairy sector)
My name is Adedapo Damilola Adeola. I am a final year master's student of the Estonian University of Life Sciences. These interview questions are part of my master thesis research project.

Question 1 on impact on input supply

- Did the lockdown that happened during the COVID-19 and the closure of borders cause input shortages? if so, what strategies were adopted?

Question 2 on management of the pandemic impacts'

- Were there meetings among stakeholders to agree on a common crisis management strategy?

Question 3

- What was responsible for the dairy farms decrease from (2015-2020)?

Question 4

- How was the communication on crisis management during the COVID-19 pandemic?
- Who was it for?

Question 5

- Did new projects emerge in response to the crisis?

Question 6

- How did the COVID-19 affect foreign trade volumes in the dairy sector in Estonia?

Question 7

- What are the recommendations from the impact of COVID-19 on the Estonian dairy sector?